



PROJECT MANUAL

Modernization Kitchen & Canteen

**VA Medical Center - Ann Arbor
Ann Arbor, Michigan**

November 14, 2011

Book 2 of 2

**ALBERT KAHN ASSOCIATES, INC.
7430 SECOND AVENUE
DETROIT, MICHIGAN 48202-2798**

**DEPARTMENT OF VETERANS AFFAIRS
VHA MASTER SPECIFICATIONS**

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SECTION 21 05 11
COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The requirements of this Section apply to all sections of Division 21.
- B. Definitions:
 - 1. Exposed: Piping and equipment exposed to view in finished rooms.
 - 2. Option or optional: Contractor's choice of an alternate material or method.

1.2 RELATED WORK

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 07 84 00, FIRESTOPPING.
- D. Section 07 92 00, JOINT SEALANTS.
- E. Section 09 91 00, PAINTING.

1.3 QUALITY ASSURANCE

- A. Products Criteria:
 - 1. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 3 years. See other specification sections for any exceptions.
 - 2. Equipment Service: Products shall be supported by a service organization which maintains a complete inventory of repair parts and provide responsive service within 24 hours of notification.
 - 3. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.
 - 4. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.
 - 5. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped or otherwise permanently marked on each item of equipment.
 - 6. Asbestos products or equipment or materials containing asbestos shall not be used.

- B. Manufacturer's Recommendations: Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished to the Contracting Officer Technical Representative prior to installation. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material.
- C. Supports for sprinkler piping shall be in conformance with NFPA 13.

1.4 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data: Submit under the pertinent section rather than under this section.
 - 1. Equipment and materials identification.
 - 2. Fire-stopping materials.
 - 3. Hangers, inserts, supports and bracing. Provide load calculations for variable spring and constant support hangers.
 - 4. Wall, floor, and ceiling plates.
- C. Coordination Drawings: Provide detailed layout drawings of all piping systems. Provide details of the following.
 - 1. Hangers, inserts, supports, and bracing.
 - 2. Pipe sleeves.
- D. Maintenance Data and Operating Instructions:
 - 1. Maintenance and operating manuals in accordance with Section 01 00 00, GENERAL REQUIREMENTS, Article, INSTRUCTIONS, for systems and equipment.
 - 2. Provide a listing of recommended replacement parts for keeping in stock supply, including sources of supply, for equipment. Include in the listing belts for equipment.

1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. National Fire Protection Association (NFPA):
 - 90A-96.....Installation of Air Conditioning and Ventilating Systems
 - 101-97.....Life Safety Code

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS IDENTIFICATION

- A. Use symbols, nomenclature and equipment numbers specified, shown on the drawings and shown in the maintenance manuals. Identification for piping is specified in Section 09 91 00, PAINTING.
- B. Valve Tags and Lists:
 - 1. Valve tags: Engraved black filled numbers and letters not less than 13 mm (1/2-inch) high for number designation, and not less than 6.4 mm (1/4-inch) for service designation on 19 gage 38 mm (1-1/2 inches) round brass disc, attached with brass "S" hook or brass chain.
 - 2. Valve lists: Typed or printed plastic coated card(s), sized 216 mm (8-1/2 inches) by 280 mm (11 inches) showing tag number, valve function and area of control, for each service or system. Punch sheets for a 3-ring notebook.
 - 3. Provide detailed plan for each floor of the building indicating the location and valve number for each valve. Identify location of each valve with a color coded thumb tack in ceiling.

2.2 FIRESTOPPING

Section 07 84 00, FIRESTOPPING specifies an effective barrier against the spread of fire, smoke and gases where penetrations occur for piping.

2.3 PIPE PENETRATIONS

- A. Install sleeves during construction for other than blocked out floor openings for risers in mechanical bays.
- B. Penetrations are not allowed through beams or ribs, but may be installed in concrete beam flanges. Any deviation from this requirement must receive prior approval of Contracting Officer Technical Representative.
- C. Sheet Metal, Plastic, or Moisture-resistant Fiber Sleeves: Provide for pipe passing through floors, interior walls, and partitions, unless brass or steel pipe sleeves are specifically called for below.
- D. Sleeves are not required for wall hydrants for fire department connections or in drywall construction.
- E. Sleeve Clearance: Sleeve through floors, walls, partitions, and beam flanges shall be one inch greater in diameter than external diameter of pipe. Sleeve for pipe with insulation shall be large enough to accommodate the insulation. Interior openings shall be caulked tight with fire stopping material and sealant to prevent the spread of fire, smoke, and gases.
- F. Sealant and Adhesives: Shall be as specified in Section 07 92 00, JOINT SEALANTS.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Coordinate location of piping, sleeves, inserts, hangers, and equipment. Locate piping, sleeves, inserts, hangers, and equipment clear of windows, doors, openings, light outlets, and other services and utilities. Follow manufacturer's published recommendations for installation methods not otherwise specified.
- B. Protection and Cleaning:
 - 1. Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the manufacturer's recommendations and as approved by the Contracting Officer Technical Representative. Damaged or defective items in the opinion of the Contracting Officer Technical Representative, shall be replaced.
 - 2. Protect all finished parts of equipment, such as shafts and bearings where accessible, from rust prior to operation by means of protective grease coating and wrapping. Close pipe openings with caps or plugs during installation. Tightly cover and protect equipment against dirt, water chemical, or mechanical injury. At completion of all work thoroughly exposed materials and equipment.
- C. Painting:
 - 1. Finish painting for work under Division 21 is specified in Section 09 9100, Painting.
- D. Work in Existing Building:
 - 1. Perform as specified in Article, OPERATIONS AND STORAGE AREAS, Article, ALTERATIONS, and Article, RESTORATION of the Section 01 00 00, GENERAL REQUIREMENTS for relocation of existing equipment, alterations and restoration of existing building(s).
 - 2. As specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, OPERATIONS AND STORAGE AREAS, make alterations to existing service piping at times that will least interfere with normal operation of the facility.
 - 3. Cut required openings through existing masonry and reinforced concrete using diamond core drills. Use of pneumatic hammer type drills, impact type electric drills, and hand or manual hammer type drills, will be permitted only with approval of the Contracting Officer Technical Representative. Locate openings that will least effect structural slabs, columns, ribs or beams. Refer to the Contracting Officer Technical Representative for determination of proper design for openings through structural sections and opening

layouts approval, prior to cutting or drilling into structure. After Contracting Officer Technical Representative's approval, carefully cut opening through construction no larger than absolutely necessary for the required installation.

3.2 OPERATING AND PERFORMANCE TESTS

- A. Prior to the final inspection, perform required tests as specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, TESTS and submit the test reports and records to the Contracting Officer Technical Representative.
- B. Should evidence of malfunction in any tested system, or piece of equipment or component part thereof, occur during or as a result of tests, make proper corrections, repairs or replacements, and repeat tests at no additional cost to the Government.
- C. When completion of certain work or system occurs at a time when final control settings and adjustments cannot be properly made to make performance tests, then make performance tests for heating systems and for cooling systems respectively during first actual seasonal use of respective systems following completion of work.

3.3 INSTRUCTIONS TO VAMC PERSONNEL

Provide in accordance with Article, INSTRUCTIONS, of Section 01 00 00, GENERAL REQUIREMENTS.

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SECTION 21 13 13
WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. Design, installation and testing shall be in accordance with NFPA 13 except for specified exceptions.
- B. The design and installation of a hydraulically calculated automatic wet system complete and ready for operation, for all portions of Building indicated on drawings.
- C. Modification of the existing sprinkler system as indicated on the drawings and as further required by these specifications.

1.2 RELATED WORK

- A. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Section 07 84 00, FIRESTOPPING, Treatment of penetrations through rated enclosures.
- C. Section 09 91 00, PAINTING.
- D. Section 28 31 00, FIRE DETECTION AND ALARM, Connection to fire alarm of flow switches, pressure switches and valve supervisory switches.
- E. Section 21 05 11 COMMON WORK RESULTS FOR FIRE SUPPRESSION

1.3 QUALITY ASSURANCE

- A. Installer Reliability: The installer shall possess a valid State of Michigan contractor's license. The installer shall have been actively and successfully engaged in the installation of commercial automatic sprinkler systems for the past three years.
- B. Materials and Equipment: All equipment and devices shall be of a make and type listed by UL and approved by FM, or other nationally recognized testing laboratory for the specific purpose for which it is used. All materials, devices, and equipment shall be approved by the VA.
- C. Submittals: Submit as one package in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES. Prepare detailed working drawings that are signed by a NICET Level III or Level IV Sprinkler Technician or stamped by a Registered Professional Engineer practicing in the field of Fire Protection Engineering. As Government review is for technical adequacy only, the installer remains responsible for correcting any conflicts with other trades and building construction that arise during installation. Partial submittals will not be accepted. Material submittals shall be approved prior to the purchase or delivery

to the job site. Suitably bind submittals in notebooks or binders and provide index referencing the appropriate specification section. Submittals shall include, but not be limited to, the following:

1. Qualifications:
 - a. Provide a copy of the installing contractor's state contractor's license.
 - b. Provide a copy of the NICET certification for the NICET Level III or Level IV Sprinkler Technician who prepared and signed the detailed working drawings unless the drawings are stamped by a Registered Professional Engineer practicing in the field of Fire Protection Engineering.
2. Drawings: Submit detailed 1:100 (1/8 inch) scale (minimum) working drawings conforming to NFPA 13. Include a site plan showing the piping to the water supply test location.
3. Manufacturers Data Sheets:
 - a. Provide for materials and equipment proposed for use on the system. Include listing information and installation instructions in data sheets. Where data sheet describes items in addition to that item being submitted, clearly identify proposed item on the sheet.
4. Calculation Sheets: Submit hydraulic calculation sheets in tabular form conforming to the requirements and recommendations of NFPA 13.
5. Final Document Submittals: Provide as-built drawings, testing and maintenance instructions in accordance with the requirements in Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES. Submittals shall include, but not be limited to, the following:
 - a. One complete set of reproducible as-built drawings showing the installed system with the specific interconnections between the waterflow switch or pressure switch and the fire alarm equipment.
 - b. Complete, simple, understandable, step-by-step, testing instructions giving recommended and required testing frequency of all equipment, methods for testing all equipment, and a complete trouble shooting manual. Provide maintenance instructions on replacing any components of the system including internal parts, periodic cleaning and adjustment of the equipment and components with information as to the address and telephone number of both the manufacturer and the local supplier of each item.

- c. Material and Testing Certificate: Upon completion of the sprinkler system installation or any partial section of the system, including testing and flushing, provide a copy of a completed Material and Testing Certificate as indicated in NFPA 13.
 - d. Certificates shall document all parts of the installation.
 - e. Instruction Manual: Provide one copy of the instruction manual covering the system in a flexible protective cover and mount in an accessible location adjacent to the riser.
- D. Design Basis Information: Provide design, materials, equipment, installation, inspection, and testing of the automatic sprinkler system in accordance with the requirements of NFPA 13. Recommendations in appendices shall be treated as requirements.
- 1. Perform hydraulic calculations in accordance with NFPA 13 utilizing the Area/Density method. Do not restrict design area reductions permitted for using quick response sprinklers throughout by the required use of standard response sprinklers in the areas identified in this section.
 - 2. Sprinkler Protection: To determining spacing and sizing, apply the coverage classifications indicated on the drawings.
 - 3. Hydraulic Calculations: Calculated demand including hose stream requirements shall fall no less than 10 percent below the available water supply curve.
 - 4. Water Supply: Obtain latest fire pump test report from Contracting Officer's Technical Representative.

1.4 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. National Fire Protection Association (NFPA):
 - 13-2007.....Installation of Sprinkler Systems
 - 101-2003.....Safety to Life from Fire in Buildings and Structures (Life Safety Code)
 - 170-1999.....Fire Safety Symbols
- C. Underwriters Laboratories, Inc. (UL):
 - 2006 Fire Protection Equipment Directory
- D. Factory Mutual Engineering Corporation (FM):
 - 2006.....Approval Guide
- E. International Building Code - 2009
- F. Foundation for Cross-Connection Control and Hydraulic Research-2005

PART 2 PRODUCTS

2.1 GENERAL

All devices and equipment shall be Underwriters Laboratories Inc. listed for their intended purpose. All sprinklers shall be Factory Mutual approved.

2.2 PIPING & FITTINGS

- A. Sprinkler systems in accordance with NFPA 13.
- B. Piping Materials Standards:
 - 1. Ferrous piping - follow ASTM A 795 Standard
 - 2. Welded and seamless steel pipe - follow ANSI/ASTM A 53
 - 3. Wrought steel pipe - follow ANSI/ASME B36.10M
 - 4. Electric resistance welded steel pipe - follow ASTM A 135
- C. Fitting Materials Standards:
 - 1. Cast iron threaded fitting, Class 125 and 250 - follow ASME B16.4
 - 2. Cast iron pipe flanges and flanged fittings - follow ASME B16.1
 - 3. Malleable iron threaded fittings, Class 150 and 300 steel - follow ASME B16.3
 - 4. Factory made wrought steel buttweld fittings - follow ASME B16.9
 - 5. Buttwelding ends for pipe, valves, flanges, and fitting - follow ASME B16.25
- D. Pipe Identification - All pipe, including specially listed pipe allowed by NFPA 13, shall be marked continuously along its length by the manufacturer in such a way as to properly identify the type of pipe. Pipe identification shall include the manufacturer's name, model designation, or schedule.

2.3 VALVES

- A. Valves in accordance with NFPA 13.
- B. Do not use quarter turn ball valves for 50 mm (2 inch) or larger drain valves.
- C. Drain Valves: Threaded bronze angle, globe, ball or butterfly, 1000 kPa (150 lb.) WOG or equal equipped with reducer and hose connection with cap or connected to a drain line.

2.4 SPRINKLERS

- A. Quick response sprinklers shall be standard type except as noted below. The maximum distance from the deflector to finished ceiling shall be 50 mm (2 in.) for pendent sprinklers. Pendent sprinklers in finished areas shall be provided with semi-recessed adjustable screwed escutcheons and installed within the center one-third of their adjustment. The sprinkler shall be installed in the flush position with the element exposed below the ceiling line. At the specified locations,

provide the following type of sprinklers. All sprinklers except "institutional" type sprinklers shall be FM approved. Provide quick response sprinklers in all areas, except where specifically prohibited by their listing or approval, and the following:

LOCATION	TYPE
Mechanical Equipment Rooms, Electrical & Electrical Switch Gear Rooms	Quick Response, Upright or Telephone Closets, Transformer Vaults Pendent Brass [93 °C (200 °F)]
Cold rooms, Freezers, Controlled Temperature Rooms and Unheated Areas	Standard Pendent, Dry Type [66- 74 °C (150-165 °F)]
Kitchen Hoods, Exhaust Ducts & Duct Collars	Standard Pendent or Upright (Extra High Temperature [163-191 °C (325- 375 °F.)])
Elevator Lobbies and Corridors	Quick Response, Recessed Pendent, Chrome Plated [66-74 °C [150- 165 °F)]
All Areas Not Listed Above	Quick Response, Recessed Pendent, Chrome Plated [66-74 °C (150- 165 °F)]

- B. Do not use quick response sprinklers in the same sprinkler zone with other sprinklers types. In sprinklered light hazard patient zones that are expanded into fully sprinklered zones, revise the existing system to contain quick response sprinklers.
- C. Sprinklers to be installed as per NFPA 13.
- D. Provide a guard for each sprinkler in janitor's closets.

2.5 SPRINKLER CABINET

Provide sprinkler cabinet with the required number of sprinkler heads of all ratings and types installed, and a sprinkler wrench for each system. Locate adjacent to the riser. Sprinkler heads shall be installed in center of tile or center to center.

2.6 IDENTIFICATION SIGNS/HYDRAULIC PLACARDS

Plastic, steel or aluminum signs with white lettering on a red background with holes for easy attachment. Enter pertinent data for each system on the hydraulic placard.

2.7 PIPE HANGERS AND SUPPORTS

Supports, hangers, etc., of an approved pattern placement to conform to NFPA 13. System piping shall be substantially supported to the building structure. The installation of hangers and supports shall adhere to the requirements set forth in NFPA 13, Standard for Installation of

Sprinkler Systems. Materials used in the installation or construction of hangers and supports shall be listed and approved for such application. Hangers or supports not specifically listed for service shall be designed and bear the seal of a professional engineer.

2.8 WALL, FLOOR AND CEILING PLATES

Provide chrome plated steel escutcheon plates for exposed piping passing through walls, floors or ceilings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be accomplished by the licensed contractor. Provide a qualified technician, experienced in the installation and operation of the type of system being installed, to supervise the installation and testing of the system.
- B. Installation of Piping: Accurately cut pipe to measurements established by the installer and work into place without springing or forcing. In any situation where bending of the pipe is required, use a standard pipe-bending template. Install concealed piping in spaces that have finished ceilings. Where ceiling mounted equipment exists, such as in operating and radiology rooms, install sprinklers so as not to obstruct the movement or operation of the equipment. Sidewall heads may need to be utilized. Locate piping in stairways as near to the ceiling as possible to prevent tampering by unauthorized personnel, and to provide a minimum headroom clearance of 2250 mm (seven feet six inches). To prevent an obstruction to egress, provide piping clearances in accordance with NFPA 101.
- C. Welding: Conform to the requirements and recommendations of NFPA 13.
- D. Drains: Pipe drains to discharge at safe points outside of the building or to sight cones attached to drains of adequate size to readily carry the full flow from each drain under maximum pressure. Do not provide a direct drain connection to sewer system or discharge into sinks. Install drips and drains where necessary and required by NFPA 13.
- E. Kitchen Ventilator Hood Fire Protection: Provide piping from the building sprinkler system to the stub-out point on the ventilator control cabinet. Size piping in accordance with manufacturer specifications.
- F. Sleeves: Provide for pipes passing through masonry or concrete. Provide space between the pipe and the sleeve in accordance with NFPA 13. Seal this space with a UL Listed through penetration fire stop material in

accordance with Section 07 84 00, FIRESTOPPING. Where core drilling is used in lieu of sleeves, also seal space. Seal penetrations of walls, floors and ceilings of other types of construction, in accordance with Section 07 84 00, FIRESTOPPING.

- G. Firestopping shall comply with Section 07 84 00, FIRESTOPPING.
- H. Securely attach identification signs to control valves, drain valves, and test valves. Locate hydraulic placard information signs at each sectional control valve where there is a zone water flow switch.
- I. Repairs: Repair damage to the building or equipment resulting from the installation of the sprinkler system by the installer at no additional expense to the Government.
- J. Interruption of Service: There shall be no interruption of the existing sprinkler protection, water, electric, or fire alarm services without prior permission of the Contracting Officer. Contractor shall develop an interim fire protection program where interruptions involve in occupied spaces. Request in writing at least one week prior to the planned interruption.

3.2 INSPECTION AND TEST

- A. Preliminary Testing: Flush newly installed systems prior to performing hydrostatic tests in order to remove any debris which may have been left as well as ensuring piping is unobstructed. Hydrostatically test system, including the fire department connections, as specified in NFPA 13, in the presence of the Contracting Officers Technical Representative (COR) or his designated representative. Test and flush underground water line prior to performing these hydrostatic tests.
- B. Final Inspection and Testing: Subject system to tests in accordance with NFPA 13, and when all necessary corrections have been accomplished, advise Contracting Officer Technical Representative to schedule a final inspection and test. Connection to the fire alarm system shall have been in service for at least ten days prior to the final inspection, with adjustments made to prevent false alarms. Furnish all instruments, labor and materials required for the tests and provide the services of the installation foreman or other competent representative of the installer to perform the tests. Correct deficiencies and retest system as necessary, prior to the final acceptance. Include the operation of all features of the systems under normal operations in test.

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**SECTION 22 05 11
COMMON WORK RESULTS FOR PLUMBING**

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The requirements of this Section shall apply to all sections of Division 22.
- B. Definitions:
 - 1. Exposed: Piping and equipment exposed to view in finished rooms.
 - 2. Option or optional: Contractor's choice of an alternate material or method.

1.2 RELATED WORK

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 07 84 00, FIRESTOPPING.
- D. Section 07 60 00, FLASHING AND SHEET METAL: Flashing for Wall and Roof Penetrations.
- E. Section 07 92 00, JOINT SEALANTS.
- F. Section 09 91 00, PAINTING.
- G. Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION.

1.3 QUALITY ASSURANCE

- A. Products Criteria:
 - 1. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 3 years. However, digital electronics devices, software and systems such as controls, instruments, computer work station, shall be the current generation of technology and basic design that has a proven satisfactory service record of at least three years.
 - 2. Equipment Service: There shall be permanent service organizations, authorized and trained by manufacturers of the equipment supplied. These organizations shall come to the site and provide acceptable service to restore operations within four hours of receipt of notification by phone, e-mail or fax in event of an emergency, such as the shut-down of equipment; or within 24 hours in a non-emergency. Names, mail and e-mail addresses and phone numbers of service organizations

- providing service under these conditions for (as applicable to the project): pumps, critical instrumentation, computer workstation and programming shall be submitted for project record and inserted into the operations and maintenance manual.
3. All items furnished shall be free from defects that would adversely affect the performance, maintainability and appearance of individual components and overall assembly.
 4. The products and execution of work specified in Division 22 shall conform to the referenced codes and standards as required by the specifications. Local codes and amendments enforced by the local code official shall be enforced, if required by local authorities such as the natural gas supplier. If the local codes are more stringent, then the local code shall apply. Any conflicts shall be brought to the attention of the Contracting Officers Technical Representative (COR).
 5. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.
 6. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.
 7. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped or otherwise permanently marked on each item of equipment.
 8. Asbestos products or equipment or materials containing asbestos shall not be used.
- B. Welding: Before any welding is performed, contractor shall submit a certificate certifying that welders comply with the following requirements:
1. Qualify welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualifications".
 2. Comply with provisions of ASME B31 series "Code for Pressure Piping".

3. Certify that each welder has passed American Welding Society (AWS) qualification tests for the welding processes involved, and that certification is current.
 4. All welds shall be stamped according to the provisions of the American Welding Society.
- C. Manufacturer's Recommendations: Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished to the Contracting Officer Technical Representative prior to installation. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material.
- D. Execution (Installation, Construction) Quality:
1. All items shall be applied and installed in accordance with manufacturer's written instructions. Conflicts between the manufacturer's instructions and the contract drawings and specifications shall be referred to the COR for resolution. Written hard copies or computer files of manufacturer's installation instructions shall be provided to the COR at least two weeks prior to commencing installation of any item.
 2. Complete layout drawings shall be required by Paragraph, SUBMITTALS. Construction work shall not start on any system until the layout drawings have been approved.
- E. Guaranty: Warranty of Construction, FAR clause 52.246-21.
- F. Plumbing Systems: IPC, International Plumbing Code.

1.4 SUBMITTALS

- A. Submittals shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 22 05 11, COMMON WORK RESULTS FOR PLUMBING", with applicable paragraph identification.
- C. Contractor shall make all necessary field measurements and investigations to assure that the equipment and assemblies will meet contract requirements.

- D. If equipment is submitted which differs in arrangement from that shown, provide drawings that show the rearrangement of all associated systems. Approval will be given only if all features of the equipment and associated systems, including accessibility, are equivalent to that required by the contract.
- E. Prior to submitting shop drawings for approval, contractor shall certify in writing that manufacturers of all major items of equipment have each reviewed drawings and specifications, and have jointly coordinated and properly integrated their equipment and controls to provide a complete and efficient installation.
- F. Upon request by Government, lists of previous installations for selected items of equipment shall be provided. Contact persons who will serve as references, with telephone numbers and e-mail addresses shall be submitted with the references.
- G. Manufacturer's Literature and Data: Manufacturer's literature shall be submitted under the pertinent section rather than under this section.
 - 1. Electric motor data and variable speed drive data shall be submitted with the driven equipment.
 - 2. Equipment and materials identification.
 - 3. Fire stopping materials.
 - 4. Hangers, inserts, supports and bracing. Provide load calculations for variable spring and constant support hangers.
 - 5. Wall, floor, and ceiling plates.
- H. Coordination Drawings: Complete consolidated and coordinated layout drawings shall be submitted for all new systems, and for existing systems that are in the same areas. The drawings shall include plan views, elevations and sections of all systems and shall be on a scale of not less than 1:32 (3/8-inch equal to one foot). Clearly identify and dimension the proposed locations of the principal items of equipment. The drawings shall clearly show the proposed location and adequate clearance for all equipment, piping, pumps, valves and other items. All valves, trap primer valves, water hammer arrestors, strainers, and equipment requiring service shall be provided with an access door sized for the complete removal of plumbing device, component, or equipment. Equipment foundations shall not be installed until equipment or piping until layout drawings have been approved. Detailed layout drawings shall be provided for all piping systems. In addition, details of the following shall be provided.

1. Mechanical equipment rooms.
2. Hangers, inserts, supports, and bracing.
3. Pipe sleeves.
4. Equipment penetrations of floors, walls, ceilings, or roofs.

I. Maintenance Data and Operating Instructions:

1. Maintenance and operating manuals in accordance with Section 01 00 00, GENERAL REQUIREMENTS, Article, INSTRUCTIONS, for systems and equipment.
2. Listing of recommended replacement parts for keeping in stock supply, including sources of supply, for equipment shall be provided.

1.5 DELIVERY, STORAGE AND HANDLING

A. Protection of Equipment:

1. Equipment and material placed on the job site shall remain in the custody of the Contractor until phased acceptance, whether or not the Government has reimbursed the Contractor for the equipment and material. The Contractor is solely responsible for the protection of such equipment and material against any damage.
2. Damaged equipment shall be replaced with an identical unit as determined and directed by the COR. Such replacement shall be at no additional cost to the Government.
3. Interiors of new equipment and piping systems shall be protected against entry of foreign matter. Both inside and outside shall be cleaned before painting or placing equipment in operation.
4. Existing equipment and piping being worked on by the Contractor shall be under the custody and responsibility of the Contractor and shall be protected as required for new work.

B. Cleanliness of Piping and Equipment Systems:

1. Care shall be exercised in the storage and handling of equipment and piping material to be incorporated in the work. Debris arising from cutting, threading and welding of piping shall be removed.
2. Piping systems shall be flushed, blown or pigged as necessary to deliver clean systems.
3. The interior of all tanks shall be cleaned prior to delivery and beneficial use by the Government. All piping shall be tested in accordance with the specifications and the International Plumbing Code (IPC), latest edition. All filters, strainers, fixture faucets shall be flushed of debris prior to final acceptance.

4. Contractor shall be fully responsible for all costs, damage, and delay arising from failure to provide clean systems.

1.6 APPLICABLE PUBLICATIONS

- A. The publications listed below shall form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society of Mechanical Engineers (ASME):
Boiler and Pressure Vessel Code (BPVC):
SEC IX-2007.....Boiler and Pressure Vessel Code; Section IX,
Welding and Brazing Qualifications.
- C. American Society for Testing and Materials (ASTM):
A36/A36M-2008.....Standard Specification for Carbon Structural
Steel
- D. Manufacturers Standardization Society (MSS) of the Valve and Fittings Industry, Inc:
SP-58-02.....Pipe Hangers and Supports-Materials, Design and
Manufacture
SP 69-2003 (R 2004).....Pipe Hangers and Supports-Selection and
Application
- E. International Code Council, (ICC):
IBC-09.....International Building Code
IPC-09.....International Plumbing Code

PART 2 - PRODUCTS

2.1 FACTORY-ASSEMBLED PRODUCTS

- A. Standardization of components shall be maximized to reduce spare part requirements.
- B. Manufacturers of equipment assemblies that include components made by others shall assume complete responsibility for final assembled unit.
 1. All components of an assembled unit need not be products of same manufacturer.
 2. Constituent parts that are alike shall be products of a single manufacturer.
 3. Components shall be compatible with each other and with the total assembly for intended service.
 4. Contractor shall guarantee performance of assemblies of components, and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly.

- C. Components of equipment shall bear manufacturer's name and trademark, model number, serial number and performance data on a name plate securely affixed in a conspicuous place, or cast integral with, stamped or otherwise permanently marked upon the components of the equipment.
- D. Major items of equipment, which serve the same function, shall be the same make and model

2.2 COMPATIBILITY OF RELATED EQUIPMENT

- A. Equipment and materials installed shall be compatible in all respects with other items being furnished and with existing items so that the result will be a complete and fully operational system that conforms to contract requirements.

2.3 EQUIPMENT AND MATERIALS IDENTIFICATION

- A. Use symbols, nomenclature and equipment numbers specified, shown on the drawings, or shown in the maintenance manuals. Identification for piping is specified in Section 09 91 00, PAINTING.
- B. Valve Tags and Lists:
 1. Plumbing: All valves shall be provided with valve tags and listed on a valve list (Fixture stops not included).
 2. Valve tags: Engraved black filled numbers and letters not less than 13 mm (1/2-inch) high for number designation, and not less than 6.4 mm (1/4-inch) for service designation on 19 gage, 38 mm (1-1/2 inches) round brass disc, attached with brass "S" hook or brass chain.
 3. Valve lists: Valve lists shall be created using a word processing program and printed on plastic coated cards. The plastic coated valve list card(s), sized 216 mm (8-1/2 inches) by 280 mm (11 inches) shall show valve tag number, valve function and area of control for each service or system. The valve list shall be in a punched 3-ring binder notebook. A copy of the valve list shall be mounted in picture frames for mounting to a wall.
 4. A detailed plan for each floor of the building indicating the location and valve number for each valve shall be provided. Each valve location shall be identified with a color coded sticker or thumb tack in ceiling.

2.4 FIRE STOPPING

- A. Section 07 84 00, FIRESTOPPING specifies an effective barrier against the spread of fire, smoke and gases where penetrations occur for piping. Refer to Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION, for pipe insulation.

2.5 PIPE AND EQUIPMENT SUPPORTS AND RESTRAINTS

- A. In lieu of the paragraph which follows, suspended equipment support and restraints may be designed and installed in accordance with the International Building Code (IBC), latest edition. Submittals based on the International Building Code (IBC), latest edition, or the following paragraphs of this Section shall be stamped and signed by a professional engineer registered in a state where the project is located. The Support system of suspended equipment over 227 kg (500 pounds) shall be submitted for approval of the Contracting Officer Technical Representative in all cases. See these specifications for lateral force design requirements.
- B. Type Numbers Specified: MSS SP-58. For selection and application refer to MSS SP-69. Refer to Section 05 50 00, METAL FABRICATIONS, for miscellaneous metal support materials and prime coat painting.
- C. For Attachment to Concrete Construction:
 - 1. Concrete insert: Type 18, MSS SP-58.
 - 2. Self-drilling expansion shields and machine bolt expansion anchors: Permitted in concrete not less than 102 mm (4 inches) thick when approved by the Contracting Officer Technical Representative for each job condition.
 - 3. Power-driven fasteners: Permitted in existing concrete or masonry not less than 102 mm (4 inches) thick when approved by the Contracting Officer Technical Representative for each job condition.
- D. For Attachment to Steel Construction: MSS SP-58.
 - 1. Welded attachment: Type 22.
 - 2. Beam clamps: Types 20, 21, 28 or 29. Type 23 C-clamp may be used for individual copper tubing up to 23 mm (7/8-inch) outside diameter.
- E. Hanger Rods: Hot-rolled steel, ASTM A36 or A575 for allowable load listed in MSS SP-58. For piping, provide adjustment means for controlling level or slope. Types 13 or 15 turn-buckles shall provide 38 mm (1-1/2 inches) minimum of adjustment and incorporate locknuts. All-thread rods are acceptable.

- F. Multiple (Trapeze) Hangers: Galvanized, cold formed, lipped steel channel horizontal member, not less than 41 mm by 41 mm (1-5/8 inches by 1-5/8 inches), 2.7 mm (No. 12 gage), designed to accept special spring held, hardened steel nuts. Trapeze hangers are not permitted for steam supply and condensate piping.
1. Allowable hanger load: Manufacturers rating less 91kg (200 pounds).
 2. Guide individual pipes on the horizontal member of every other trapeze hanger with 6 mm (1/4-inch) U-bolt fabricated from steel rod. Provide Type 40 insulation shield, secured by two 13 mm (1/2-inch) galvanized steel bands, or insulated calcium silicate shield for insulated piping at each hanger.
- G. Pipe Hangers and Supports: (MSS SP-58), use hangers sized to encircle insulation on insulated piping. Refer to Section 23 07 11, HVAC, PLUMBING, and BOILER PLANT INSULATION for insulation thickness. To protect insulation, provide Type 39 saddles for roller type supports or insulated calcium silicate shields. Provide Type 40 insulation shield or insulated calcium silicate shield at all other types of supports and hangers including those for insulated piping.
1. General Types (MSS SP-58):
 - a. Standard clevis hanger: Type 1; provide locknut.
 - b. Riser clamps: Type 8.
 - c. Wall brackets: Types 31, 32 or 33.
 - d. Roller supports: Type 41, 43, 44 and 46.
 - e. Saddle support: Type 36, 37 or 38.
 - f. Turnbuckle: Types 13 or 15.
 - g. U-bolt clamp: Type 24.
 - h. Copper Tube:
 - 1) Hangers, clamps and other support material in contact with tubing shall be painted with copper colored epoxy paint, plastic coated or taped with isolation tape to prevent electrolysis.
 - 2) For vertical runs use epoxy painted or plastic coated riser clamps.
 - 3) For supporting tube to strut: Provide epoxy painted pipe straps for copper tube or plastic inserted vibration isolation clamps.
 - 4) Insulated Lines: Provide pre-insulated calcium silicate shields sized for copper tube.

- i. Supports for plastic or glass piping: As recommended by the pipe manufacturer with black rubber tape extending one inch beyond steel support or clamp.
- 2. Plumbing Piping (Other Than General Types):
 - a. Horizontal piping: Type 1, 5, 7, 9, and 10.
 - b. Chrome plated piping: Chrome plated supports.
 - c. Hangers and supports in pipe chase: Prefabricated system ABS self-extinguishing material, not subject to electrolytic action, to hold piping, prevent vibration and compensate for all static and operational conditions.
 - d. Blocking, stays and bracing: Angle iron or preformed metal channel shapes, 1.3 mm (18 gage) minimum.
- H. Pre-insulated Calcium Silicate Shields:
 - 1. Provide 360 degree water resistant high density 965 kPa (140 psi) compressive strength calcium silicate shields encased in galvanized metal.
 - 2. Pre-insulated calcium silicate shields to be installed at the point of support during erection.
 - 3. Shield thickness shall match the pipe insulation.
 - 4. The type of shield is selected by the temperature of the pipe, the load it must carry, and the type of support it will be used with.
 - a. Shields for supporting cold water shall have insulation that extends a minimum of one inch past the sheet metal.
 - b. The insulated calcium silicate shield shall support the maximum allowable water filled span as indicated in MSS-SP 69. To support the load, the shields shall have one or more of the following features: structural inserts 4138 kPa (600 psi) compressive strength, an extra bottom metal shield, or formed structural steel (ASTM A36) wear plates welded to the bottom sheet metal jacket.
 - 5. Shields may be used on steel clevis hanger type supports, roller supports or flat surfaces.

2.6 PIPE PENETRATIONS

- A. Pipe penetration sleeves shall be installed for all pipe other than rectangular blocked out floor openings for risers in mechanical bays.
- B. Pipe penetration sleeve materials shall comply with all fire stopping requirements for each penetration.

- C. To prevent accidental liquid spills from passing to a lower level, provide the following:
 - 1. For sleeves: Extend sleeve 25 mm (1 inch) above finished floor and provide sealant for watertight joint.
 - 2. For blocked out floor openings: Provide 40 mm (1-1/2 inch) angle set in silicone adhesive around opening.
 - 3. For drilled penetrations: Provide 40 mm (1-1/2 inch) angle ring or square set in silicone adhesive around penetration.
- D. Penetrations are not allowed through beams or ribs, but may be installed in concrete beam flanges. Any deviation from these requirements must receive prior approval of Contracting Officer Technical Representative.
- E. Sheet metal, plastic, or moisture resistant fiber sleeves shall be provided for pipe passing through floors, interior walls, and partitions, unless brass or steel pipe sleeves are specifically called for below.
- F. Brass Pipe Sleeves shall be provided for pipe passing through quarry tile, terrazzo or ceramic tile floors. The sleeve shall be connected with a floor plate.
- G. Sleeve clearance through floors, walls, partitions, and beam flanges shall be 25 mm (1 inch) greater in diameter than external diameter of pipe. Sleeve for pipe with insulation shall be large enough to accommodate the insulation plus 25 mm (1 inch) in diameter. Interior openings shall be caulked tight with fire stopping material and sealant to prevent the spread of fire, smoke, and gases.
- H. Sealant and Adhesives: Shall be as specified in Section 07 92 00, JOINT SEALANTS.

2.7 WALL, FLOOR AND CEILING PLATES

- A. Material and Type: Chrome plated brass or chrome plated steel, one piece or split type with concealed hinge, with set screw for fastening to pipe, or sleeve. Use plates that fit tight around pipes, cover openings around pipes and cover the entire pipe sleeve projection.
- B. Thickness: Not less than 2.4 mm (3/32-inch) for floor plates. For wall and ceiling plates, not less than 0.64 mm (0.025-inch) for up to 80 mm (3 inch) pipe, 0.89 mm (0.035-inch) for larger pipe.

- C. Locations: Use where pipe penetrates floors, walls and ceilings in exposed locations, in finished areas only. Wall plates shall be used where insulation ends on exposed water supply pipe drop from overhead. A watertight joint shall be provided in spaces where brass or steel pipe sleeves are specified.

2.8 ASBESTOS

Materials containing asbestos are not permitted.

PART 3 - EXECUTION

3.1 ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING

- A. Location of piping, sleeves, inserts, hangers, and equipment, access provisions shall be coordinated with the work of all trades. Piping, sleeves, inserts, hangers, and equipment shall be located clear of windows, doors, openings, light outlets, and other services and utilities. Equipment layout drawings shall be prepared to coordinate proper location and personnel access of all facilities. The drawings shall be submitted for review.

Manufacturer's published recommendations shall be followed for installation methods not otherwise specified.

- B. Operating Personnel Access and Observation Provisions: All equipment and systems shall be arranged to provide clear view and easy access, without use of portable ladders, for maintenance and operation of all devices including, but not limited to: all equipment items, valves, filters, strainers, transmitters, sensors, control devices. All gages and indicators shall be clearly visible by personnel standing on the floor or on permanent platforms. Maintenance and operating space and access provisions that are shown on the drawings shall not be changed nor reduced.
- C. Structural systems necessary for pipe and equipment support shall be coordinated to permit proper installation.
- D. Location of pipe sleeves, trenches and chases shall be accurately coordinated with equipment and piping locations.
- E. Cutting Holes:
 - 1. Holes through concrete and masonry shall be cut by rotary core drill. Pneumatic hammer, impact electric, and hand or manual hammer type drill will not be allowed, except as permitted by Contracting Officer's Technical Representative where working area space is limited.

2. Holes shall be located to avoid interference with structural members such as beams or grade beams. Holes shall be laid out in advance and drilling done only after approval by COR. If the Contractor considers it necessary to drill through structural members, this matter shall be referred to COR for approval.
 3. Waterproof membrane shall not be penetrated. Pipe floor penetration block outs shall be provided outside the extents of the waterproof membrane.
- F. Minor Piping: Generally, small diameter pipe runs from drips and drains, water cooling, and other service are not shown but must be provided.
- G. Protection and Cleaning:
1. Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the manufacturer's recommendations and as approved by the Contracting Officer Technical Representative. Damaged or defective items, in the opinion of the Contracting Officer Technical Representative, shall be replaced.
 2. Protect all finished parts of equipment, such as shafts and bearings where accessible, from rust prior to operation by means of protective grease coating and wrapping. Close pipe openings with caps or plugs during installation. Pipe openings, equipment, and plumbing fixtures shall be tightly covered against dirt or mechanical injury. At completion of all work thoroughly clean fixtures, exposed materials and equipment.
- H. Work in Existing Building:
1. Perform as specified in Article, OPERATIONS AND STORAGE AREAS, Article, ALTERATIONS, and Article, RESTORATION of the Section 01 00 00, GENERAL REQUIREMENTS for relocation of existing equipment, alterations and restoration of existing building(s).
 2. As specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, OPERATIONS AND STORAGE AREAS, make alterations to existing service piping at times that will cause the least interfere with normal operation of the facility.
- I. Work in bathrooms, restrooms, housekeeping closets: All pipe penetrations behind escutcheons shall be sealed with plumbers putty.

J. Inaccessible Equipment:

1. Where the Government determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled or remedial action performed as directed at no additional cost to the Government.
2. The term "conveniently accessible" is defined as capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as electrical conduit, motors, fans, pumps, belt guards, transformers, high voltage lines, piping, and ductwork.

3.2 TEMPORARY PIPING AND EQUIPMENT

- A. Continuity of operation of existing facilities may require temporary installation or relocation of equipment and piping. Temporary equipment or pipe installation or relocation shall be provided to maintain continuity of operation of existing facilities.
- B. The Contractor shall provide all required facilities in accordance with the requirements of phased construction and maintenance of service. All piping and equipment shall be properly supported, sloped to drain, operate without excessive stress, and shall be insulated where injury can occur to personnel by contact with operating facilities. The requirements of Para. 3.1 shall apply.
- C. Temporary facilities and piping shall be completely removed and any openings in structures sealed. Necessary blind flanges and caps shall be provided to seal open piping remaining in service.

3.3 PIPE AND EQUIPMENT SUPPORTS

- A. Where hanger spacing does not correspond with joist or rib spacing, use structural steel channels secured directly to joist and rib structure that will correspond to the required hanger spacing, and then suspend the equipment and piping from the channels. Holes shall be drilled or burned in structural steel ONLY with the prior written approval of the Contracting Officer Technical Representative.
- B. The use of chain pipe supports, wire or strap hangers; wood for blocking, stays and bracing, or hangers suspended from piping above shall not be permitted. Rusty products shall be replaced.
- C. Hanger rods shall be used that are straight and vertical. Turnbuckles for vertical adjustments may be omitted where limited space prevents use. A minimum of 15 mm (1/2-inch) clearance between pipe or piping covering and adjacent work shall be provided.

D. For horizontal and vertical plumbing pipe supports, refer to the International Plumbing Code (IPC), latest edition, and these specifications.

E. Overhead Supports:

1. The basic structural system of the building is designed to sustain the loads imposed by equipment and piping to be supported overhead.
2. Provide steel structural members, in addition to those shown, of adequate capability to support the imposed loads, located in accordance with the final approved layout of equipment and piping.
3. Tubing and capillary systems shall be supported in channel troughs.

F. Floor Supports:

1. Provide concrete bases, concrete anchor blocks and pedestals, and structural steel systems for support of equipment and piping. Concrete bases and structural systems shall be anchored and doweled to resist forces under operating and seismic conditions (if applicable) without excessive displacement or structural failure.
2. Bases and supports shall not be located and installed until equipment mounted thereon has been approved. Bases shall be sized to match equipment mounted thereon plus 50 mm (2 inch) excess on all edges. Structural drawings shall be reviewed for additional requirements. Bases shall be neatly finished and smoothed, shall have chamfered edges at the top, and shall be suitable for painting.
3. All equipment shall be shimmed, leveled, firmly anchored, and grouted with epoxy grout. Anchor bolts shall be placed in sleeves, anchored to the bases. Fill the annular space between sleeves and bolts with a grout material to permit alignment and realignment.

G. Hanger spacing: Maximum allowed spacings of pipe supports are indicated in the tables. Hanger rod sizes are minimum size allowed. Contractor's attention is directed to drawing details and building structural layout that may require hanger spacing more frequently than spacings shown in this table.

Screwed or welded steel pipe (liquid or vapor)

<u>Pipe Size</u>	<u>Maximum Hanger Spacing</u>	<u>Minimum Rod Size</u>
1/2 to 1 inch	8 feet	3/8 inch
1-1/4 through 2 inches	10 feet	3/8 inch
2-1/2 to 3-1/2 inches	12 feet	1/2 inch
4 and 5 inches	16 feet	5/8 inch

Copper tubing

<u>Pipe Size</u>	<u>Maximum Hanger Spacing</u>	<u>Minimum Rod Size</u>
1-1/4 inch and smaller	5 feet	3/8 inch
1-1/2 inches	7 feet	3/8 inch
2 inches	10 feet	3/8 inch
2-1/2 through 3-1/2 inches	10 feet	1/2 inch
4 inches	10 feet	5/8 inch

3.4 PLUMBING SYSTEMS DEMOLITION

- A. Unless specified otherwise, all piping, wiring, conduit, and other devices associated with the equipment not re-used in the new work shall be completely removed from Government property. This includes all concrete equipment pads, pipe, valves, fittings, insulation, and all hangers including the top connection and any fastenings to building structural systems. All openings shall be sealed after removal of equipment, pipes, ducts, and other penetrations in roof, walls, floors, in an approved manner and in accordance with plans and specifications where specifically covered. Structural integrity of the building system shall be maintained. Reference shall also be made to the drawings and specifications of the other disciplines in the project for additional facilities to be demolished or handled.
- B. All valves including gate, globe, ball, butterfly and check, all pressure gages and thermometers with wells shall remain Government property and shall be removed and delivered to COR and stored as directed. The Contractor shall remove all other material and equipment, devices and demolition debris under these plans and specifications. Such material shall be removed from Government property expeditiously and shall not be allowed to accumulate.

3.5 CLEANING AND PAINTING

- A. Prior to final inspection and acceptance of the plant and facilities for beneficial use by the Government, the plant facilities, equipment and systems shall be thoroughly cleaned and painted. Refer to Section 09 91 00, PAINTING.

- B. In addition, the following special conditions apply:
1. Cleaning shall be thorough. Solvents, cleaning materials and methods recommended by the manufacturers shall be used for the specific tasks. All rust shall be removed prior to painting and from surfaces to remain unpainted. Scratches, scuffs, and abrasions shall be repaired prior to applying prime and finish coats.
 2. The following Material And Equipment shall NOT be painted::
 - a. Motors, controllers, control switches, and safety switches.
 - b. Control and interlock devices.
 - c. Regulators.
 - d. Pressure reducing valves.
 - e. Control valves and thermostatic elements.
 - f. Lubrication devices and grease fittings.
 - g. Copper, brass, aluminum, stainless steel and bronze surfaces.
 - h. Valve stems and rotating shafts.
 - i. Pressure gages and thermometers.
 - j. Glass.
 - k. Name plates.
 3. Temporary Facilities: Apply paint to surfaces that do not have existing finish coats.
 4. The final result shall be a smooth, even-colored, even-textured factory finish on all items. The entire piece of equipment shall be repainted, if necessary, to achieve this.

3.6 IDENTIFICATION SIGNS

- A. Laminated plastic signs, with engraved lettering not less than 5 mm (3/16-inch) high, shall be provided that designates equipment function, for all equipment, switches, motor controllers, relays, meters, control devices, including automatic control valves. Nomenclature and identification symbols shall correspond to that used in maintenance manual, and in diagrams specified elsewhere. Attach by chain, adhesive, or screws.
- B. Factory Built Equipment: Metal plate, securely attached, with name and address of manufacturer, serial number, model number, size, performance shall be placed on factory built equipment.
- C. Pipe Identification: Refer to Section 09 91 00, PAINTING.

3.7 STARTUP AND TEMPORARY OPERATION

- A. Start up of equipment shall be performed as described in the equipment specifications. Vibration within specified tolerance shall be verified prior to extended operation. Temporary use of equipment is specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, TEMPORARY USE OF MECHANICAL AND ELECTRICAL EQUIPMENT.

3.8 OPERATING AND PERFORMANCE TESTS

- A. Prior to the final inspection, all required tests shall be performed as specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, TESTS and submit the test reports and records to the Contracting Officer Technical Representative.
- B. Should evidence of malfunction in any tested system, or piece of equipment or component part thereof, occur during or as a result of tests, make proper corrections, repairs or replacements, and repeat tests at no additional cost to the Government.
- C. When completion of certain work or system occurs at a time when final control settings and adjustments cannot be properly made to make performance tests, then make performance tests such systems respectively during first actual seasonal use of respective systems following completion of work.

3.9 OPERATION AND MAINTENANCE MANUALS

- A. Provide four bound copies. The Operations and maintenance manuals shall be delivered to COR not less than 30 days prior to completion of a phase or final inspection.
- B. All new and temporary equipment and all elements of each assembly shall be included.
- C. Data sheet on each device listing model, size, capacity, pressure, speed, horsepower, impeller size, and other information shall be included.
- D. Manufacturer's installation, maintenance, repair, and operation instructions for each device shall be included. Assembly drawings and parts lists shall also be included. A summary of operating precautions and reasons for precautions shall be included in the Operations and Maintenance Manual.
- E. Lubrication instructions, type and quantity of lubricant shall be included.
- F. Schematic diagrams and wiring diagrams of all control systems corrected to include all field modifications shall be included.

- G. Setpoints of all interlock devices shall be listed.
- H. Trouble-shooting guide for the control system troubleshooting guide shall be inserted into the Operations and Maintenance Manual.
- I. The combustion control system sequence of operation corrected with submittal review comments shall be inserted into the Operations and Maintenance Manual.
- J. Emergency procedures.

3.10 INSTRUCTIONS TO VAMC PERSONNEL

Instructions shall be provided in accordance with Article,
INSTRUCTIONS, of Section 01 00 00, GENERAL REQUIREMENTS.

- - - E N D - - -

SECTION 22 05 23
GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section describes the requirements for general-duty valves for domestic water and sewer systems.

1.2 RELATED WORK

- A. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

1.3 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data:
1. Valves.
 2. Backflow Preventers.
 3. All items listed in Part 2 - Products.

1.4 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society for Testing and Materials (ASTM):
- A536-84(R 2004) Standard Specification for Ductile Iron Castings
- C. American Society of Sanitary Engineering (ASSE)
- ASSE 1003-01 (R 2003)...Performance Requirements for Water Pressure Reducing Valves
- ASSE 1012-02.....Backflow Preventer with Intermediate Atmospheric Vent
- ASSE 1013-05.....Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Principle Backflow Preventers
- D. International Code Council (ICC)
- IPC-06 (R 2007).....International Plumbing Code
- E. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):
- SP-25-98.....Standard Marking System for Valves, Fittings, Flanges and Unions
- SP-67-02a (R 2004) Butterfly Valve of the Single flange Type (Lug Wafer)

SP-70-06.....Cast Iron Gate Valves, Flanged and Threaded
Ends.

SP-72-99.....Ball Valves With Flanged or Butt Welding For
General Purpose

SP-80-03.....Bronze Gate, Globe, Angle and Check Valves.

SP-110-96.....Ball Valve Threaded, Socket Welding, Solder
Joint, Grooved and Flared Ends

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Valves shall be prepared for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set angle, gate, and globe valves closed to prevent rattling.
 - 4. Set ball and plug valves open to minimize exposure of functional surfaces
 - 5. Set butterfly valves closed or slightly open.
 - 6. Block check valves in either closed or open position.
- B. Valves shall be prepared for storage as follows:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher than ambient dew point temperature.
- C. A sling shall be used for large valves. The sling shall be rigged to avoid damage to exposed parts. Hand wheels or stems shall not be used as lifting or rigging points.

PART 2 - PRODUCTS

2.1 VALVES

- A. Asbestos packing and gaskets are prohibited.
- B. Bronze valves shall be made with dezincification resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc shall not be permitted.
- C. Valves in insulated piping shall have 50 mm or DN50 (2 inch) stem extensions and extended handles of non-thermal conductive material that allows operating the valve without breaking the vapor seal or disturbing the insulation. Memory stops shall be fully adjustable after insulation is applied.
- D. Exposed Valves over 65 mm or DN65 (2-1/2 inches) installed at an elevation over 3.6 meters (12 feet) shall have a chain-wheel attachment to valve hand-wheel, stem, or other actuator.

E. Ball valves, pressure regulating valves, gate valves, globe valves, and plug valves used to supply potable water shall meet the requirements of NSF 61.

F. Shut-off:

1. Cold, Hot and Re-circulating Hot Water:

a. 50 mm or DN50 (2 inches) and smaller: Ball, MSS SP-72, SP-110, Ball valve shall be full port three piece or two piece with a union design with adjustable stem package. Threaded stem designs are not allowed. The ball valve shall have a SWP rating of 1035 kPa (150 psig) and a CWP rating of 4140 kPa (600 psig). The body material shall be Bronze ASTM B584, Alloy C844. The ends shall be solder,

b. Less than 100 mm DN100 (4 inches): Butterfly shall have an iron body with EPDM seal and aluminum bronze disc. The butterfly valve shall meet MSS SP-67, type I standard. The butterfly valve shall have a SWP rating of 1380 kPa (200 psig). The valve design shall be lug type suitable for bidirectional dead-end service at rated pressure. The body material shall meet ASTM A 536, ductile iron.

c. 100 mm (DN100) (4 inches) and larger:

1) Class 125, OS&Y, Cast Iron Gate Valve. The gate valve shall meet MSS-SP-70 type I standard. The gate valve shall have a CWP rating of 1380 kPa (200 psig). The valve materials shall meet ASTM A 126, grey iron with bolted bonnet, flanged ends, bronze trim, and solid wedge disc. The gate valve shall be gear operated for sizes under 200 mms or DN200 (8 inches) and crank operated for sizes 200 mms or DN200 (8 inches) and above

2) Single flange, ductile iron butterfly valves: The single flanged butterfly valve shall meet the MSS SP-67 standard. The butterfly valve shall have a CWP rating of 1380 kPa (200 psig). The butterfly valve shall be lug type, suitable for bidirectional dead-end service at rated pressure without use of downstream flange. The body material shall comply with ASTM A536 ductile iron. The seat shall be EPDM with stainless steel disc and stem.

- 3) Grooved end, ductile iron butterfly valves. The grooved butterfly valve shall meet the MSS SP-67 standard. The grooved butterfly valve shall have a CWP rating of 1380 kPa (200 psig). The valve materials shall be polyamide coated ductile iron conforming to ASTM A536 with two-piece stainless steel stem, EPDM encapsulated ductile iron disc, and EPDM seal. The butterfly valve shall be gear operated

G. Balancing:

1. Hot Water Re-circulating, 80 mm or DN80 (3 inches) and smaller manual balancing valve shall be of bronze body, brass ball construction with glass and carbon filled TFE seat rings and designed for positive shutoff. The manual balancing valve shall have differential pressure read-out ports across the valve seat area. The read out ports shall be fitting with internal EPT inserts and check valves. The valve body shall have 8 mm or DN8 NPT (¼" NPT) tapped drain and purge port. The valves shall have memory stops that allow the valve to close for service and then reopened to setpoint without disturbing the balance position. All valves shall have calibrated nameplates to assure specific valve settings.
2. Larger than 80 mm or DN80 (3 inches): Manual balancing valves shall be of heavy duty cast iron flanged construction with 862 kPa (125 psi) flange connections. The flanged manual balancing valves shall have either a brass ball with glass and carbon filled TFE seal rings or fitted with a bronze seat, replaceable bronze disc with EPDM seal insert and stainless steel stem. The design pressure shall be 1207 kPa (175) at 121 deg C (250 deg F).

H. Check:

1. Check valves less than 80 mm or DN80 (3 inches) and smaller) shall be class 125, bronze swing check valves with non metallic Buna-N disc. The check valve shall meet MSS SP-80 Type 4 standard. The check valve shall have a CWP rating of 1380 kPa (200 psig). The check valve shall have a Y pattern horizontal body design with bronze body material conforming to ASTM B 62, solder joints, and PTFE or TFE disc.

2. Larger than 100 mm or DN100 (4 inches and larger):
 - a. Check valves shall be class 125, iron swing check valve with lever and weight closure control. The check valve shall meet MSS SP-71 Type I standard. The check valve shall have a CWP rating of 1380 kPa (200 psig). The check valve shall have a clear or full waterway body design with gray iron body material conforming to ASTM A 126, bolted bonnet, flanged ends, bronze trim.
 - b. All check valves on the discharge side of submersible sump pumps shall have factory installed exterior level and weight with sufficient weight to prevent the check valve from hammering against the seat when the sump pump stops.

I. Globe:

1. 80 mm or DN80 (3 inches) or smaller: Class 150, bronze globe valve with non metallic disc. The globe valve shall meet MSS SP-80, Type 2 standard. The globe valve shall have a CWP rating of 2070 kPa (300 psig). The valve material shall be bronze with integral seal and union ring bonnet conforming to ASTM B 62 with solder ends, copper-silicon bronze stem, TPFPE or TFE disc, malleable iron hand wheel.
2. Larger than 80 mm or DN80 (3 inches): Similar to above, except with cast iron body and bronze trim, class 125, iron globe valve. The globe valve shall meet MSS SP-85, Type 1 standard. The globe valve shall have a CWP rating of 1380 kPa (200 psig). The valve material shall be gray iron with bolted bonnet conforming to ASTM A 126 with flanged ends, bronze trim, malleable iron handwheel.

2.2 BACKFLOW PREVENTERS

- A. A backflow prevention assembly shall be installed at any point in the plumbing system where the potable water supply comes in contact with a potential source of contamination. The backflow prevention assembly shall be ASSE 1013 listed and certified.
- B. Reduced pressure backflow preventers shall be installed in the following applications.
 1. Atmospheric Vacuum Breaker: ASSE 1001
 - a. Hose bibs and sinks w/threaded outlets.
 - b. Disposers.
 - c. All kitchen equipment, if not protected by air gap.

- C. The reduced pressure principle backflow prevention assembly shall be ASSE listed 1013 with full port OS&Y gate valves and an integral relief monitor switch. The main body and access cover shall be epoxy coated duct iron conforming to ASTM A536 grade 4. The seat ring and check valve shall be Noryl (NSF listed). The stem shall be stainless steel conforming to ASTM A276. The seat disc elastomer shall be EPDM. The checks and the relief valve shall be accessible for maintenance without removing the device from the line. An epoxy coated wye type strainer with flanged connections shall be installed on the inlet.
- D. The atmospheric vacuum breaker shall be ASSE listed 1001. The main body shall be either cast bronze. All internal polymers shall be NSF listed. The seat disc elastomer shall be silicone. The device shall be accessible for maintenance without removing the device from the service line. The installation shall not be in a concealed or inaccessible location or where the venting of water from the device during normal operation is deemed objectionable.
- E. The double check detector backflow prevention assembly shall be ASSE listed 1048 and supply with full port OS&Y gate valves. The main body and access cover shall be epoxy coated ductile iron conforming to ASTM A536 grade. The seat ring and check valve shall be Noryl (NSF listed). The stem shall be stainless steel conforming to ASTM A 276. The seat disc elastomers shall be EPDM. The first and second check valve shall be accessible for maintenance without removing the device from the line.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Valve interior shall be examined for cleanliness, freedom from foreign matter, and corrosion. Special packing materials shall be removed, such as blocks, used to prevent disc movement during shipping and handling.
- B. Valves shall be operated in positions from fully open to fully closed. Guides and seats shall be examined and made accessible by such operations.
- C. Threads on valve and mating pipe shall be examined for form and cleanliness.

- D. Mating flange faces shall be examined for conditions that might cause leakage. Bolting shall be checked for proper size, length, and material. Gaskets shall be verified for proper size and that its material composition is suitable for service and free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Valves shall be located for easy access and shall be provide with separate support. Valves shall be accessible with access doors when installed inside partitions or above hard ceilings.
- C. Valves shall be installed in horizontal piping with stem at or above center of pipe
- D. Valves shall be installed in a position to allow full stem movement.
- E. Check valves shall be installed for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.

3.3 ADJUSTING

- A. Valve packing shall be adjusted or replaced after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves shall be replaced if persistent leaking occurs.

- - E N D - - -

**SECTION 22 11 00
FACILITY WATER DISTRIBUTION**

PART 1 - GENERAL

1.1 DESCRIPTION

Domestic water systems, including piping, equipment and all necessary accessories as designated in this section.

1.2 RELATED WORK

- A. Penetrations in rated enclosures: Section 07 84 00, FIRESTOPPING.
- B. Preparation and finish painting and identification of piping systems: Section 09 91 00, PAINTING.
- C. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- D. Pipe Insulation: Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION.

1.3 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data:
 - 1. Piping.
 - 2. Strainers.
 - 3. All items listed in Part 2 - Products.

1.4 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American National Standards Institute (ANSI):
 - American Society of Mechanical Engineers (ASME): (Copyrighted Society)
 - A13.1-96.....Scheme for Identification of Piping Systems
 - B16.4-98.....Cast Iron Threaded Fittings Classes 125 and 250
ANSI/ASME
 - B16.9-01.....Factory-Made Wrought Steel Buttwelding Fittings
ANSI/ASME
 - B16.11-01.....Forged Steel Fittings, Socket-Welding and
Threaded ANSI/ASME
 - B16.12-98.....Cast Iron Threaded Drainage Fittings ANSI/ASME
 - B16.15-85(R 1994).....Cast Bronze Threaded Fittings ANSI/ASME
 - B16.18-01.....Cast Copper Alloy Solder-Joint Pressure
Fittings ANSI/ASME

B16.22-01.....Wrought Copper and Copper Alloy Solder Joint
 Pressure Fittings ANSI/ASME
 Element ANSI/ASME

C. American Society for Testing and Materials (ASTM):

A47-99.....Ferritic Malleable Iron Castings Revision 1989
 A183-83(R1998).....Carbon Steel Track Bolts and Nuts
 A536-84(R1999) E1.....Ductile Iron Castings
 B32-03.....Solder Metal
 B75-99(Rev A).....Seamless Copper Tube
 B88-03.....Seamless Copper Water Tube
 B584-00.....Copper Alloy Sand Castings for General
 Applications Revision A
 D4101-03b.....Propylene Plastic Injection and Extrusion
 Materials
 D2564-94.....Solvent Cements for Poly (Vinyl Chloride) (PVC)
 Plastic Pipe and Fittings
 D2665-94 Revision A.....Poly (Vinyl Chloride) (PVC) Plastic Drain,
 Waste, and Vent Pipe and Fittings
 D4101-03b.....Propylene Plastic Injection and Extrusion
 Materials
 E1120.....Standard Specification For Liquid Chlorine
 E1229.....Standard Specification For Calcium Hypochlorite

D. American Water Works Association (AWWA):

C110-03/ A21.10-03.....Ductile Iron and Gray Iron Fittings - 75 mm
 thru 1200 mm (3 inch thru 48 inches) for Water
 and other liquids AWWA/ ANSI
 C151-00/ A21.51-02.....Ductile-Iron Pipe, Centrifugally Cast in Metal
 Molds or Sand-Lined Molds, for Water or Other
 Liquids AWWA/ ANSI
 C203-02.....Coal-Tar Protective Coatings and Linings for
 Steel Water Pipelines - Enamel and Tape - Hot
 Applied AWWA/ ANSI
 C651-99.....Disinfecting Water Mains

E. American Welding Society (AWS):

A5.8-92.....Filler Metals for Brazing

- F. National Association of Plumbing - Heating - Cooling Contractors (PHCC):
National Standard Plumbing Code - 1996
- G. International Association of Plumbing and Mechanical Officials (IAPMO):
Uniform Plumbing Code - 2000
IS6-93.....Installation Standard
- H. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):
SP-72-99.....Ball Valves With Flanged or Butt Welding For
General Purpose
SP-110-96.....Ball Valve Threaded, Socket Welding, Solder
Joint, Grooved and Flared Ends
- I. American Society of Sanitary Engineers (ASSE):
1001-02.....Pipe Applied Atmospheric Type Vacuum Breakers
1018-01.....Performance for trap seal primer valve-water
supply fed
1020-04.....Vacuum Breakers, Anti-Siphon, Pressure Type
- J. Plumbing and Drainage Institute (PDI):
PDI WH-201.....Water Hammer Arrestor

PART 2 - PRODUCTS

2.1 INTERIOR DOMESTIC WATER PIPING

- A. Pipe: Copper tube, ASTM B88, Type K or L, drawn. For pipe 150 mm (6 inches) and larger, stainless, steel ASTM A312, schedule 10 may be used.
- B. Fittings for Copper Tube:
 - 1. Wrought copper or bronze castings conforming to ANSI B16.18 and B16.22. Unions shall be bronze, MSS SP72 & SP 110, Solder or braze joints.
 - 2. Grooved fittings, 50 to 150 mm (2 to 6 inch) wrought copper ASTM B75 C12200, 125 to 150 mm (5 to 6 inch) bronze casting ASTM B584, CDA 844. Mechanical grooved couplings, ductile iron, ASTM A536 (Grade 65-45-12), or malleable iron, ASTM A47 (Grade 32510) housing, with EPDM gasket, steel track head bolts, ASTM A183, coated with copper colored alkyd enamel.

3. Mechanically formed tee connection: Form mechanically extracted collars in a continuous operation by drilling pilot hole and drawing out tube surface to form collar, having a height of not less than three times the thickness of tube wall. Adjustable collaring device shall insure proper tolerance and complete uniformity of the joint. Notch and dimple joining branch tube in a single process to provide free flow where the branch tube penetrates the fitting. Braze joints.

C. Adapters: Provide adapters for joining screwed pipe to copper tubing.

D. Solder: ASTM B32 Composition Sb5 HA or HB. Provide non-corrosive flux.

E. Brazing alloy: AWS A5.8, Classification BCuP.

2.2 EXPOSED WATER PIPING

- A. Finished Room: Use full iron pipe size chrome plated brass piping for exposed water piping connecting fixtures, casework, cabinets, equipment and reagent racks when not concealed by apron including those furnished by the Government or specified in other sections.

1. Pipe: Fed. Spec. WW-P-351, standard weight.

2. Fittings: ANSI B16.15 cast bronze threaded fittings with chrome finish, (125 and 250).

3. Nipples: ASTM B 687, Chromium-plated.

4. Unions: Mss SP-72, SP-110, Brass or Bronze with chrome finish.

Unions 65 mm (2-1/2 inches) and larger shall be flange type with approved gaskets.

- B. Unfinished Rooms, Mechanical Rooms and Kitchens: Chrome-plated brass piping is not required. Paint piping systems as specified in Section 09 91 00, PAINTING.

2.3 TRAP PRIMER WATER PIPING:

A. Pipe: Copper tube, ASTM B88, type K, hard drawn.

B. Fittings: Bronze castings conforming to ANSI B16.18 Solder joints.

C. Solder: ASTM B32 composition Sb5. Provide non-corrosive flux.

2.4 WATERPROOFING

- A. Provide at points where pipes pass through membrane waterproofed floors or walls in contact with earth.

B. Floors: Provide cast iron stack sleeve with flashing device and a underdeck clamp. After stack is passed through sleeve, provide a waterproofed caulked joint at top hub.

C. Walls: See detail shown on drawings.

2.5 STRAINERS

- A. Provide on high pressure side of pressure reducing valves, on suction side of pumps, on inlet side of indicating and control instruments and equipment subject to sediment damage and where shown on drawings. Strainer element shall be removable without disconnection of piping.
- B. Water: Basket or "Y" type with easily removable cover and brass strainer basket.
- C. Body: Smaller than 80 mm (3 inches), brass or bronze; 80 mm (3 inches) and larger, cast iron or semi-steel.

2.6 DIELECTRIC FITTINGS

Provide dielectric couplings or unions between ferrous and non-ferrous pipe.

2.7 STERILIZATION CHEMICALS

- A. Liquid Chlorine: ASTM E1120.
- B. Hypochlorite: ASTM E1229, or Fed. Spec. AA-1427C, grade B.

2.8 WATER HAMMER ARRESTER:

Closed copper tube chamber with permanently sealed 410 kPa (60 psig) air charge above a Double O-ring piston. Two high heat Buna-N O-rings pressure packed and lubricated with FDA approved Dow Corning No. 11 silicone compound. All units shall be designed in accordance with ASSE 1010 for sealed wall installations without an access panel. Size and install in accordance with Plumbing and Drainage Institute requirements (PDI WH 201). Unit shall be as manufactured by Precision Plumbing Products Inc., Watts or Sioux Chief. Provide water hammer arrestors at all solenoid valves, at all groups of two or more flush valves, at all quick opening or closing valves, and at all medical washing equipment.

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. General: Comply with the PHCC National Standard Plumbing Code and the following:
 - 1. Install branch piping for water from the piping system and connect to all fixtures, valves, cocks, outlets, casework, cabinets and equipment, including those furnished by the Government or specified in other sections.
 - 2. Pipe shall be round and straight. Cutting shall be done with proper tools. Pipe, except for plastic and glass, shall be reamed to full size after cutting.

3. All pipe runs shall be laid out to avoid interference with other work.
4. Install union and shut-off valve on pressure piping at connections to equipment.
5. Pipe Hangers, Supports and Accessories:
 - a. All piping shall be supported per of the National Standard Plumbing Code, Chapter No. 8.
 - b. Shop Painting and Plating: Hangers, supports, rods, inserts and accessories used for Pipe supports shall be shop coated with red lead or zinc Chromate primer paint. Electroplated copper hanger rods, hangers and accessories may be used with copper tubing.
 - c. Floor, Wall and Ceiling Plates, Supports, Hangers:
 - 1) Solid or split unplated cast iron.
 - 2) All plates shall be provided with set screws.
 - 3) Pipe Hangers: Height adjustable clevis type.
 - 4) Adjustable Floor Rests and Base Flanges: Steel.
 - 5) Concrete Inserts: "Universal" or continuous slotted type.
 - 6) Hanger Rods: Mild, low carbon steel, fully threaded or Threaded at each end with two removable nuts at each end for positioning rod and hanger and locking each in place.
 - 7) Riser Clamps: Malleable iron or steel.
 - 8) Rollers: Cast iron.
 - 9) Self-drilling type expansion shields shall be "Phillips" type, with case hardened steel expander plugs.
 - 10) Hangers and supports utilized with insulated pipe and tubing shall have 180 degree (min.) metal protection shield Centered on and welded to the hanger and support. The shield shall be 4 inches in length and be 16 gauge steel. The shield shall be sized for the insulation.
 - 11) Miscellaneous Materials: As specified, required, directed or as noted on the drawings for proper installation of hangers, supports and accessories. If the vertical distance exceeds 6 m (20 feet) for cast iron pipe additional support shall be provided in the center of that span. Provide all necessary auxiliary steel to provide that support.
6. Install cast escutcheon with set screw at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.

7. Penetrations:

- a. Fire Stopping: Where pipes pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases as specified in Section 07 84 00, FIRESTOPPING. Completely fill and seal clearances between raceways and openings with the fire stopping materials.
 - b. Waterproofing: At floor penetrations, completely seal clearances around the pipe and make watertight with sealant as specified in Section 07 92 00, JOINT SEALANTS.
- B. Piping shall conform to the following:
- 1. Domestic Water:
 - a. Where possible, grade all lines to facilitate drainage. Provide drain valves at bottom of risers. All unnecessary traps in circulating lines shall be avoided.
 - b. Connect branch lines at bottom of main serving fixtures below and pitch down so that main may be drained through fixture. Connect branch lines to top of main serving only fixtures located on floor above.

3.2 TESTS

- A. General: Test system either in its entirety or in sections.
- B. Potable Water System: Test after installation of piping and domestic water heaters, but before piping is concealed, before covering is applied, and before plumbing fixtures are connected. Fill systems with water and maintain hydrostatic pressure of 690 kPa (100 psi) gage for two hours. No decrease in pressure is allowed. Provide a pressure gage with a shutoff and bleeder valve at the highest point of the piping being tested.
- C. All Other Piping Tests: Test new installed piping under 1 1/2 times actual operating conditions and prove tight.

3.3 STERILIZATION

- A. After tests have been successfully completed, thoroughly flush and sterilize the interior domestic water distribution system in accordance with AWWA C651.
- B. Use either liquid chlorine or hypochlorite for sterilization.

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**SECTION 22 13 00
FACILITY SANITARY AND VENT PIPING**

PART 1 - GENERAL

1.1 DESCRIPTION

This section pertains to sanitary sewer and vent systems, including piping, equipment and all necessary accessories as designated in this section.

1.2 RELATED WORK

- A. Section 07 84 00, FIRESTOPPING: Penetrations in rated enclosures.
- B. Section 09 91 00, PAINTING: Preparation and finish painting and identification of piping systems.
- C. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING: Pipe Hangers and Supports, Materials Identification.
- D. Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION: Pipe Insulation.
- E. Section 07 92 00 Joint Sealants: Sealant products.

1.3 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data:
 - 1. Piping.
 - 2. Floor Drains.
 - 3. Cleanouts.
 - 4. All items listed in Part 2 - Products.
- C. Detailed shop drawing of clamping device and extensions when required in connection with the waterproofing membrane or the floor drain.

1.4 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society of Mechanical Engineers (ASME): (Copyrighted Society)
 - A112.6.3-01 (R 2007)....Standard for Floor and Trench Drains
 - A13.1-07.....Scheme for Identification of Piping Systems
 - B16.3-06.....Malleable Iron Threaded Fittings, Classes 150 and 300.
 - B16.4-06.....Standard for Grey Iron Threaded Fittings
Classes 125 and 250

B16.12-98 (R 2006).....Cast Iron Threaded Drainage Fittings
 B16.15-06.....Cast Bronze Threaded Fittings, Classes 125 and
 250

C. American Society for Testing and Materials (ASTM):

A47/A47M-99 (R 2004)....Standard Specification for Steel Sheet,
 Aluminum Coated, by the Hot Dip Process
 A53/A53M-07.....Standard Specification for Pipe, Steel, Black
 And Hot-Dipped, Zinc-coated, Welded and
 Seamless
 A74-06.....Standard Specification for Cast Iron Soil Pipe
 and Fittings
 A183-03.....Standard Specification for Carbon Steel Track
 Bolts and Nuts
 A536-84(R 2004).....Standard Specification for Ductile Iron
 Castings
 B32-08.....Standard Specification for Solder Metal
 B75-02.....Standard Specification for Seamless Copper Tube
 B306-02.....*Standard Specification for Copper Drainage Tube*
 (DWV)
 B584-06a.....Standard Specification for Copper Alloy Sand
 Castings for General Applications
 C564-03a.....Standard Specification for Rubber Gaskets for
 Cast Iron Soil Pipe and Fittings
 D2000-08.....Standard Classification System for Rubber
 Products in Automotive Applications
 D2564-04E1.....Standard Specification for Solvent Cements for
 Poly (Vinyl Chloride) (PVC) Plastic Pipe and
 Fittings
 D2665-08.....Standard Specification for Poly (Vinyl
 Chloride) (PVC) Plastic Drain, Waste, and Vent
 Pipe and Fittings

D. International Code Council:

IPC-06.....International Plumbing Code

E. Cast Iron Soil Pipe Institute (CISPI):

301-05.....Hubless Cast Iron Soil Pipe and Fittings for
 Sanitary and Storm Drain, Waste, and Vent
 Piping Applications

310-04.....Coupling for Use in Connection with Hubless
Cast Iron Soil Pipe and Fittings for Sanitary
and Storm Drain, Waste, and Vent Piping
Applications

F. American Society of Sanitary Engineers (ASSE):

1018-01.....Trap Seal Primer Valves - Potable, Water
Supplied

G. Plumbing and Drainage Institute (PDI):

PDI WH-201.....Water Hammer Arrestor

PART 2 - PRODUCTS

2.1 SANITARY WASTE, DRAIN, AND VENT PIPING

A. Cast iron waste, drain, and vent pipe and fittings

1. Cast iron waste, drain, and vent pipe and fittings shall be used for the following applications:

- a. pipe buried in or in contact with earth
- b. sanitary pipe extensions to a distance of approximately 1500 mm (5 feet) outside of the building.
- c. interior waste and vent piping above grade.

2. Cast iron Pipe shall be bell and spigot or hubless (plain end or no-hub or hubless).

3. The material for all pipe and fittings shall be cast iron soil pipe and fittings and shall conform to the requirements of CISPI Standard 301, ASTM A-888, or ASTM A-74.

4. Joints for hubless pipe and fittings shall conform to the manufacturer's installation instructions. Couplings for hubless joints shall conform to CISPI 310. Joints for hub and spigot pipe shall be installed with compression gaskets conforming to the requirements of ASTM Standard C-564 or be installed with lead and oakum.

B. Copper Tube, (DWV):

1. Copper DWV tube sanitary waste, drain and vent pipe may be used for piping above ground, except for urinal drains.

2. The copper DWV tube shall be drainage type, drawn temper conforming to ASTM B306.

3. The copper drainage fittings shall be cast copper or wrought copper conforming to ASME B16.23 or ASME 16.29.

4. The joints shall be lead free, using a water flushable flux, and conforming to ASTM B32.

C. Polyvinyl Chloride (PVC)

1. Polyvinyl chloride (PVC) pipe and fittings are permitted where the waste temperature is below 60°C (140°F).
2. PVC piping and fittings shall NOT be used for the following applications:
 - a. Waste collected from steam condensate drains
 - b. spaces such as mechanical equipment rooms, kitchens, SPD, and sterilizer areas.
 - c. Vertical waste and soil stacks serving more than two floors
 - d. Exposed in mechanical equipment rooms.
 - e. Exposed inside of ceiling return plenums
3. Polyvinyl chloride sanitary waste, drain, and vent pipe and fittings shall be schedule 40 solid core sewer piping conforming to ASTM D 1785 and ASTM D2665, sewer and drain series with ends for solvent cemented joints.
4. Fittings:
 - a. PVC fittings shall be solvent welded socket type using solvent cement conforming to ASTM D2564.

2.2 EXPOSED WASTE PIPING

- A. Full iron pipe size chrome plated brass piping shall be used in finished rooms for exposed waste piping connecting fixtures, casework, cabinets, equipment and reagent racks when not concealed by apron including those furnished by the Government or specified in other sections.
 1. The Pipe shall meet Fed. Spec. WW-P-351, standard weight.
 2. The Fittings shall conform to ANSI B16.15, cast bronze threaded fittings with chrome finish, (125 and 250).
 3. Nipples shall conform to ASTM B 687, Chromium-plated.
 4. Unions shall be brass or bronze with chrome finish. Unions 65 mm (2-1/2 inches) and larger shall be flange type with approved gaskets.
- B. In unfinished Rooms such as mechanical Rooms and Kitchens, Chrome-plated brass piping is not required. The pipe materials specified under the paragraph "Sanitary Waste, Drain, and Vent Piping" can be used. The sanitary pipe in unfinished rooms shall be painted as specified in Section 09 91 00, PAINTING.

2.3 SPECIALTY PIPE FITTINGS

- A. Transition pipe couplings shall join piping with small differences in outside diameters or different materials. End connections shall be of the same size and compatible with the pipes being joined. The transition coupling shall be elastomeric, sleeve type reducing or transition pattern and include shear and corrosion resistant metal, tension band and tightening mechanism on each end. The transition coupling sleeve coupling shall be of the following material:
 - 1. For cast iron soil pipes, the sleeve material shall be rubber conforming to ASTM C564.
 - 2. For PVC soil pipes, the sleeve material shall be elastomeric seal or PVC, conforming to ASTM F 477 or ASTM D5926.
 - 3. For dissimilar pipes, the sleeve material shall be PVC conforming to ASTM D5926, or other material compatible with the pipe materials being joined.
- B. The dielectric fittings shall conform to ASSE 1079 with a pressure rating of 860 kPa (125 psig) at a minimum temperature of 82°C (180°F). The end connection shall be solder joint copper alloy and threaded ferrous.
- C. Dielectric flange insulating kits shall be of non conducting materials for field assembly of companion flanges with a pressure rating of 1035 kPa (150 psig). The gasket shall be neoprene or phenolic. The bolt sleeves shall be phenolic or polyethylene. The washers shall be phenolic with steel backing washers.
- D. The di-electric nipples shall be electroplated steel nipple complying with ASTM F 1545 with a pressure ratings of 2070 kPa (300 psig) at 107°C (225°F). The end connection shall be male threaded. The lining shall be inert and noncorrosive propylene.

2.4 CLEANOUTS

- A. Cleanouts shall be the same size as the pipe, up to 100 mm (4 inches); and not less than 100 mm (4 inches) for larger pipe. Cleanouts shall be easily accessible and shall be gastight and watertight. Minimum clearance of 600 mm (24 inches) shall be provided for clearing a clogged sanitary line.

- B. Floor cleanouts shall be gray iron housing with clamping device and round, secured, scoriated, gray iron cover conforming to ASME A112.36.2M. A gray iron ferrule with hubless, socket, inside calk or spigot connection and counter sunk, taper-thread, brass or bronze closure plug shall be included. The frame and cover material and finish shall be nickel-bronze copper alloy with a square shape. The cleanout shall be vertically adjustable for a minimum of 50 mm (2 inches). When a waterproof membrane is used in the floor system, clamping collars shall be provided on the cleanouts. Cleanouts shall consist of wye fittings and eighth bends with brass or bronze screw plugs. Cleanouts in the resilient tile floors, quarry tile and ceramic tile floors shall be provided with square top covers recessed for tile insertion. In the carpeted areas, carpet cleanout markers shall be provided. Two way cleanouts shall be provided where indicated on drawings and at every building exit. The loading classification for cleanouts in sidewalk areas or subject to vehicular traffic shall be heavy duty type.
- C. Cleanouts shall be provided at or near the base of the vertical stacks with the cleanout plug located approximately 600 mm (24 inches) above the floor. If there are no fixtures installed on the lowest floor, the cleanout shall be installed at the base of the stack. The cleanouts shall be extended to the wall access cover. Cleanout shall consist of sanitary tees. Nickel-bronze square frame and stainless steel cover with minimum opening of 150 by 150 mm (6 by 6 inches) shall be furnished at each wall cleanout. Where the piping is concealed, a fixture trap or a fixture with integral trap, readily removable without disturbing concealed pipe, shall be accepted as a cleanout equivalent providing the opening to be used as a cleanout opening is the size required.
- D. In horizontal runs above grade, cleanouts shall consist of cast brass tapered screw plug in fitting or caulked/hubless cast iron ferrule. Plain end (hubless) piping in interstitial space or above ceiling may use plain end (hubless) blind plug and clamp.

2.5 FLOOR DRAINS

- A. Type A (FD-A) floor drain shall comply with ANSI A112.6.3. A caulking flange, inside gasket, or hubless connection shall be provided for connection to cast iron pipe, screwed or no hub outlets for connection to steel pipe. The drain connection shall be bottom outlet. A

membrane clamp and extensions shall be provided, if required, where installed in connection with waterproof membrane. Puncturing membrane other than for drain opening will not be permitted. Double drainage pattern floor drains shall have integral seepage pan for embedding into floor construction, and weep holes to provide adequate drainage from pan to drain pipe. For drains not installed in connection with a waterproof membrane, a 2.2 kg (16-ounce) soft copper membrane, 600 mm (24 inches) square or another approved waterproof membrane shall be provided.

- B. Type C (FD-C) floor drain shall comply with ANSI A112.6.3. The type C floor drain shall have a cast iron body, double drainage pattern, clamping device, light duty square or round nickel bronze adjustable strainer and grate with vandal proof screws. The grate shall be square, 150 mm (6 inches) minimum.
- C. Type M (FD-M) floor drain shall comply with ANSI A112.6.3. The type M floor drain shall have a cast iron body, nickel bronze adjustable funnel strainer and clamping device. Funnel strainer shall consist of a perforated floor-level square or round grate and funnel extension. Minimum dimensions as follows:
 - 1. Area of strainer and collar - 23 000 square mm (36 square inches).
 - 2. Height of funnel - 95 mm (3-3/4 inches).
 - 3. Diameter of lower portion of funnel - 50 mm (2 inches).
 - 4. Diameter of top portion of funnel - 100 mm (4 inches).
 - 5. Provide paper collars for construction purposes.
- D. Type O (FD-O) floor drain shall comply with ANSI A112.6.3. The type O floor drain shall have a cast iron body, double drainage pattern, clamping device, with nickel-bronze dome type secondary strainer. The drain shall be 300 mm (12 inches) in diameter and approximately 250 mm (10 inches) deep. The interior and exposed exterior surfaces shall have an acid resisting, enamel finish. Coordinate nickel-bronze grate style with Food Service Contractor.
- E. Type P (FD-P) floor drain shall comply with ANSI A112.6.3. The type P floor drain shall have a cast iron body, double drainage pattern, clamping device, with nickel-bronze grate and perforated removable enameled basket. The drain shall be 300 mm (12 inches) in diameter and approximately 215 mm (8 1/2 inches) deep. The interior and exposed exterior surfaces shall have an acid resisting, enamel finish.

- F. Type R (FD-R) floor drain shall comply with ANSI A112.6.3. The type R floor drain shall have a cast iron body, double drainage pattern and clamping device, less grate and sediment basket but with dome type secondary strainer. The drain shall be 200 mm (8 inches) in diameter or 200 mm (8 inches) square and approximately 150 mm (6 inches) deep. The interior and exposed exterior surfaces and rim shall have an acid resisting white porcelain finish.
- G. Type S (FD-S) floor sink shall comply with ANSI A112.6.3. The type S floor sink shall be constructed from type 304 stainless steel and shall be 300 mm (12 inches) square, and 250 mm (10 inches) deep. The interior surface shall be polished. The double drainage flange shall be provided with weep holes, internal dome strainer, and heavy duty non-tilting loose set grate. A clamping device shall be provided.

2.6 TRAPS

- A. Traps shall be provided on all sanitary branch waste connections from fixtures or equipment not provided with traps. Exposed brass shall be polished brass chromium plated with nipple and set screw escutcheons. Concealed traps may be rough cast brass or same material as pipe connected to. Slip joints are not permitted on sewer side of trap. Traps shall correspond to fittings on cast iron soil pipe or steel pipe respectively, and size shall be as required by connected service or fixture.

2.7 TRAP SEAL PRIMER VALVES AND TRAP SEAL PRIMER SYSTEMS

- A. Each floor drain to be served by a single individual trap primer. Manifolds serving more than one floor drain trap are not permitted.
- B. Trap Primer (TP-1): The trap seal primer system shall be electronic type conforming to ASSE 1044.
1. The controller shall have a 24 hour programmable timer, solid state, 6 outlet zones, minimum adjustable run time of 1 minute for each zone, 12 hour program battery backup, manual switch for 120VAC power, 120VAC to 24VAC internal transformer, fuse protected circuitry, UL listed, 120VAC input-24VAC output, constructed of enameled steel or plastic.
 2. The cabinet shall be recessed mounting with a stainless steel cover.
 3. The solenoid valve shall have a brass body, Buna "N" seats, normally closed, 5.98 kPa (125 psi) rated, 24VAC.

4. The control wiring shall be copper in accordance with the latest edition of the National Electric Code, Article 725 and not less than 18 gauge. All wiring shall be in conduit and in accordance with Division 26 of the specifications.
5. The vacuum breaker shall conform to ASSE 1001.
- C. Trap Primer (TP-2): The trap seal primer valve shall be hydraulic, supply type with a pressure rating of 5.98 kPa (125 psig) and conforming to standard ASSE 1018.
 1. The inlet and outlet connections shall be 15 mm or DN15 (NPS ½ inch)
 2. The trap seal primer valve shall be fully automatic with an all brass or bronze body.
 3. The trap seal primer valve shall be activated by a drop in building water pressure, no adjustment required.
 4. The trap seal primer valve shall include a manifold when serving two, three, or four traps.
 5. The manifold shall be omitted when serving only one trap.

2.8 WATERPROOFING

- A. A sleeve flashing device shall be provided at points where pipes pass through membrane waterproofed floors or walls. The sleeve flashing device shall be manufactured, cast iron fitting with clamping device that forms a sleeve for the pipe floor penetration of the floor membrane. A galvanized steel pipe extension shall be included in the top of the fitting that will extend 50 mm (2 inches) above finished floor and galvanized steel pipe extension in the bottom of the fitting that will extend through the floor slab. A waterproof caulked joint shall be provided at the top hub.
- B. Walls: See detail shown on drawings.

PART 3 - EXECUTION

3.1 PIPE INSTALLATION

- A. The pipe installation shall comply with the requirements of the International Plumbing Code (IPC) and these specifications.
- B. Branch piping shall be installed for waste from the respective piping systems and connect to all fixtures, valves, cocks, outlets, casework, cabinets and equipment, including those furnished by the Government or specified in other sections.
- C. Pipe shall be round and straight. Cutting shall be done with proper tools. Pipe shall be reamed to full size after cutting.

- D. All pipe runs shall be laid out to avoid interference with other work.
- E. The piping shall be installed above accessible ceilings where possible.
- F. The piping shall be installed to permit valve servicing or operation.
- G. Unless specifically indicated on the drawings, the minimum slope shall be 2% slope.
- H. The piping shall be installed free of sags and bends.
- I. Seismic restraint shall be installed where required by code.
- J. Changes in direction for soil and waste drainage and vent piping shall be made using appropriate branches, bends and long sweep bends.
Sanitary tees and short sweep quarter bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Long turn double wye branch and eighth bend fittings shall be used if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Proper size of standard increaser and reducers shall be used if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- K. Cast iron piping shall be installed according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings"
- L. Aboveground copper tubing shall be installed according to CDA's "Copper Tube Handbook".
- M. Aboveground PVC piping shall be installed according to ASTM D2665.

3.2 JOINT CONSTRUCTION

- A. Hub and spigot, cast iron piping with gasket joints shall be joined in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Hub and spigot, cast iron piping with calked joints shall be joined in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
- C. Hubless or No-hub, cast iron piping shall be joined in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless piping coupling joints.

- D. For threaded joints, thread pipe with tapered pipe threads according to ASME B1.20.1. The threads shall be cut full and clean using sharp disc cutters. Threaded pipe ends shall be reamed to remove burrs and restored to full pipe inside diameter. Pipe fittings and valves shall be joined as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is required by the pipe service
 - 2. Pipe sections with damaged threads shall be replaced with new sections of pipe.
- E. Copper tube and fittings with soldered joints shall be joined according to ASTM B828. A water flushable, lead free flux conforming to ASTM B813 and a lead free alloy solder conforming to ASTM B32 shall be used.
- F. For PVC piping, solvent cement joints shall be used for joints. All surfaces shall be cleaned and dry prior to applying the primer and solvent cement. Installation practices shall comply with ASTM F402. The joint shall conform to ASTM D2855 and ASTM D2665 appendixes.

3.3 SPECIALTY PIPE FITTINGS

- A. Transition coupling shall be installed at pipe joints with small differences in pipe outside diameters.
- B. Dielectric fittings shall be installed at connections of dissimilar metal piping and tubing.

3.4 PIPE HANGERS, SUPPORTS AND ACCESSORIES:

- A. All piping shall be supported according to the International Plumbing Code (IPC), Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING, and these specifications. Where conflicts arise between these the code and Section 22 05 11, the most restrictive or the requirement that specifies supports with highest loading or shortest spacing shall apply.
- B. Hangers, supports, rods, inserts and accessories used for pipe supports shall be shop coated with zinc chromate primer paint. Electroplated copper hanger rods, hangers and accessories may be used with copper tubing.
- C. Horizontal piping and tubing shall be supported within 300 mm (12 inches) of each fitting or coupling.
- D. Horizontal cast iron piping shall be supported with the following maximum horizontal spacing and minimum hanger rod diameters:
 - 1. 40 mm or DN40 to 50 mm or DN50 (NPS 1-1/2 inch to NPS 2 inch): 1500 mm (60 inches) with 10 mm (3/8 inch) rod.

2. 80 mm or DN 80 (NPS 3 inch): 1500 mm (60 inches) with 13 mm ($\frac{1}{2}$ inch) rod.
 3. 100 mm or DN100 to 125 mm or DN125 (NPS 4 to NPS 5): 1500 mm (60 inches) with 16 mm ($\frac{5}{8}$ inch) rod.
 4. 150 mm or DN150 to 200 mm or DN200 (NPS 6 inch to NPS 8 inch): 1500 mm (60 inches) with 19 mm ($\frac{3}{4}$ inch) rod.
 5. 250 mm or DN250 to 300 mm or DN 300 (NPS 10 inch to NPS 12 inch): 1500 mm (60 inch) with 22 mm ($\frac{7}{8}$ inch) rod.
- E. The maximum spacing for plastic pipe shall be 1.22 m (4 feet).
- F. Vertical piping and tubing shall be supported at the base, at each floor, and at intervals no greater than 4.57 m (15 feet).
- G. In addition to the requirements in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING, floor, Wall and Ceiling Plates, Supports, Hangers shall have the following characteristics:
1. Solid or split unplated cast iron.
 2. All plates shall be provided with set screws.
 3. Height adjustable clevis type pipe hangers.
 4. Adjustable floor rests and base flanges shall be steel.
 5. Hanger rods shall be low carbon steel, fully threaded or threaded at each end with two removable nuts at each end for positioning rod and hanger and locking each in place.
 6. Riser clamps shall be malleable iron or steel.
 7. Rollers shall be cast iron.
 8. See Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING, for requirements on insulated pipe protective shields at hanger supports.
- H. Miscellaneous materials shall be provided as specified, required, directed or as noted on the drawings for proper installation of hangers, supports and accessories. If the vertical distance exceeds 6 m (20 feet) for cast iron pipe additional support shall be provided in the center of that span. All necessary auxiliary steel shall be provided to provide that support.
- I. Cast escutcheon with set screw shall be provided at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.

J. Penetrations:

1. Fire Stopping: Where pipes pass through fire partitions, fire walls, smoke partitions, or floors, a fire stop shall be installed that provides an effective barrier against the spread of fire, smoke and gases as specified in Section 07 84 00, FIRESTOPPING. Clearances between raceways and openings shall be completely filled and sealed with the fire stopping materials.
2. Water proofing: At floor penetrations, clearances shall be completely sealed around the pipe and make watertight with sealant as specified in Section 07 92 00, JOINT SEALANTS.

K. Piping shall conform to the following:

1. Waste and Vent Drain to main stacks:

Pipe Size	Minimum Pitch
80 mm or DN 80 (3 inches) and smaller	2%
100 mm or DN 100 (4 inches) and larger	1%

2. Exhaust vents shall be extended separately through roof. Sanitary vents shall not connect to exhaust vents.

3.5 TESTS

- A. Sanitary waste and drain systems shall be tested either in its entirety or in sections.
- B. Waste System tests shall be conducted before trenches are backfilled or fixtures are connected. A water test or air test shall be conducted, as directed.
 1. If entire system is tested for a water test, tightly close all openings in pipes except highest opening, and fill system with water to point of overflow. If the waste system is tested in sections, tightly plug each opening except highest opening of section under test, fill each section with water and test with at least a 3 m (10 foot) head of water. In testing successive sections, test at least upper 3 m (10 feet) of next preceding section so that each joint or

- pipe except upper most 3 m (10 feet) of system has been submitted to a test of at least a 3 m (10 foot) head of water. Water shall be kept in the system, or in portion under test, for at least 15 minutes before inspection starts. System shall then be tight at all joints.
2. For an air test, an air pressure of 35 kPa (5 psig) gage shall be maintained for at least 15 minutes without leakage. A force pump and mercury column gage shall be used for the air test.
 3. After installing all fixtures and equipment, open water supply so that all p-traps can be observed. For 15 minutes of operation, all p-traps shall be inspected for leaks and any leaks found shall be corrected.
 4. Final Tests: Either one of the following tests may be used.
 - a. Smoke Test: After fixtures are permanently connected and traps are filled with water, fill entire drainage and vent systems with smoke under pressure of 1.3 kPa (1 inch of water) with a smoke machine. Chemical smoke is prohibited.
 - b. Peppermint Test: Introduce (2 ounces) of peppermint into each line or stack.

- - - E N D - - -

**SECTION 22 14 00
FACILITY STORM DRAINAGE**

PART 1 - GENERAL

1.1 DESCRIPTION

This section describes the requirements for storm drainage systems, including piping and all necessary accessories as designated in this section.

1.2 RELATED WORK

- A. Section 07 84 00, FIRESTOPPING: Penetrations in rated enclosures.
- B. Section 09 91 00, PAINTING: Preparation and finish painting and identification of piping systems.
- C. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING: Pipe Hangers and Supports, Materials Identification.
- D. Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION: Pipe Insulation.

1.3 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data:
 - 1. Piping.
 - 2. Roof Drains.
 - 3. Cleanouts.
 - 4. All items listed in Part 2 - Products.
- C. Detailed shop drawing of clamping device and extensions when required in connection with the waterproofing membrane.

1.4 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society of Mechanical Engineers (ASME): (Copyrighted Society)
 - A112.21.2m-83.....Roof Drains
 - A13.1-07.....Scheme for Identification of Piping Systems
 - B16.3-06.....Malleable Iron Threaded Fittings, Classes 150 and 300. B16.9-07 Factory-Made Wrought Steel Butt welding Fittings

- B16.11-05.....Forged Steel Fittings, Socket-Welding and
Threaded B16.12-98 (R 2006) Cast Iron
Threaded Drainage Fittings
- B16.15-06).....Cast Bronze Threaded Fittings, Class 125 and
250
- B16.18-01 (R 2005).....Cast Copper Alloy Solder-Joint Pressure
Fittings
- B16.22-01 (R 2005).....Wrought Copper and Copper Alloy Solder Joint
Pressure Fittings
- C. American Society for Testing and Materials (ASTM):
- A47-99 (R 2004).....Standard Specification for Steel Sheet,
Aluminum Coated, by the Hot-Dip Process
- A53-07.....Standard Specification for Pipe, Steel, Black
And Hot-Dipped, Zinc-coated Welded and Seamless
- A74-06.....Standard Specification for Cast Iron Soil Pipe
and Fittings
- A183-03).....Standard Specification for Carbon Steel Track
Bolts and Nuts
- A312-03.....Standard Specification for Seamless and Welded
Austenitic Stainless Steel Pipe
- A536-84(R 2004).....Standard Specification for Ductile Iron
Castings
- A733-03.....Standard Specification for Welded and Seamless
Carbon Steel and Austenitic Stainless Steel
Pipe Nipples
- B32-04.....Standard Specification for Solder Metal
- B61-08.....Standard Specification for Steam or Bronze
Castings
- B62-02.....Standard Specification for Composition Bronze
or Ounce Metal Castings
- B75-02.....Standard Specification for Seamless Copper Tube
- B88-03.....Standard Specification for Seamless Copper
Water Tube
- B306-02.....Standard Specification for Copper Drainage Tube
(DWV)
- B584-08.....Standard Specification for Copper Alloy Sand
Castings for General Applications

- B687-99.....Standard Specification for Brass, Copper, and
Chromium-Plated Pipe Nipples
- C564-06a.....Standard Specification for Rubber Gaskets for
Cast Iron Soil Pipe and Fittings
- D2000-08.....Standard Classification System for Rubber
Products in Automotive Applications
- D4101-07.....Standard Specification for Propylene Plastic
Injection and Extrusion Materials
- D2447-03.....Standard Specification for Polyethylene (PE)
Plastic Pipe, Schedule 40 and 80, Based on
Outside Diameter
- D2564-04e1.....Standard Specification for Solvent Cements for
Poly (Vinyl Chloride) (PVC) Plastic Pipe and
Fittings
- D2665-07.....Standard Specification for Poly (Vinyl
Chloride) (PVC) Plastic Drain, Waste, and Vent
Pipe and Fittings
- D. American Welding Society (AWS):
- A5.8-04.....Specification for Filler Metals for Brazing and
Braze Welding
- E. International Code Council (ICC):
- IPC-06.....International Plumbing Code
- F. Cast Iron Soil Pipe Institute (CISPI):
- 301-05.....Hubless Cast Iron Soil and Fittings for
Sanitary and Storm Drain, Waste, and Vent
Piping Applications
- 310-04.....Couplings for Use in Connection with Hubless
Cast Iron Soil and Fittings for Sanitary and
Storm Drain, Waste, and Vent Piping
Applications
- G. Manufacturers Standardization Society of the Valve and Fittings
Industry, Inc. (MSS):
- SP-72-99.....Standard for Ball Valves with Flanged or Butt
Welding For General Purpose
- SP-110-96.....Ball Valve Threaded, Socket Welding, Solder
Joint, Grooved and Flared Ends

PART 2 - PRODUCTS**2.1 STORM WATER DRAIN PIPING****A. Cast Iron Storm Pipe and Fittings:**

1. Cast iron storm pipe and fittings shall be used for the following applications:
 - a. Pipe buried in or in contact with earth.
 - b. Extension of pipe to a distance of approximately 1500 mm (5 feet) outside of building walls.
 - c. Interior storm piping above grade.
 - d. All mechanical equipment rooms or other areas containing mechanical air handling equipment.
2. The cast iron storm Pipe shall be bell and spigot, or hubless (plain end or no-hub) as required by selected jointing method.
3. The material for all pipe and fittings shall be cast iron soil pipe and fittings and shall conform to the requirements of CISPI Standard 301, ASTM A-888, or ASTM A-74.
4. Joints for hubless pipe and fittings shall conform to the manufacturer's installation instructions. Couplings for hubless joints shall conform to CISPI 310. Joints for hub and spigot pipe shall be installed with compression gaskets conforming to the requirements of ASTM Standard C-564 or be installed with leak and oakum.

- B. Roof drain piping in locations where the outdoor conditions are subject to freezing shall be insulated.

2.2 SPECIALTY PIPE FITTINGS

- A. Transition pipe couplings shall join piping with small differences in outside diameters or be of different materials. End connections shall be of the same size and compatible with the pipes being joined. The transition coupling shall be elastomeric, sleeve type reducing or transition pattern and include shear erring and corrosion resistant metal tension band and tightening mechanism on each end. The transition coupling sleeve coupling shall be of the following material:
1. For cast iron soil pipes, the sleeve material shall be rubber conforming to ASTM C564.
 2. For dissimilar pipes, the sleeve material shall be PVC conforming to ASTM D5926, or other material compatible with the pipe materials being joined.

- B. The dielectric fittings shall conform to ASSE 1079 with a pressure rating of 860 kPa (125 psig) at a minimum temperature of 82°C (180°F). The end connection shall be solder joint copper alloy and threaded ferrous.
- C. Dielectric flange insulating kits shall be of nonconducting materials for field assembly of companion flanges with a pressure rating of 1035 kPa (150 psig). The gasket shall be neoprene or phenolic. The bolt sleeves shall be phenolic or polyethylene. The washers shall be phenolic with steel backing washers.
- D. The dielectric nipples shall be electroplated steel nipple comply with ASTM F 1545 with a pressure ratings of 2070 kPa (300 psig) at 107°C (225°F). The end connection shall be male threaded. The lining shall be inert and noncorrosive polypropylene.

2.3 CLEANOUTS

- A. Cleanouts shall be the same size as the pipe, up to 100 mm (4 inches); not less than 100 mm (4 inches) for larger pipe. Cleanouts shall be easily accessible and shall be gastight and watertight. A minimum clearance of 600 mm (24 inches) shall be provided for clearing a clogged storm sewer line.
- B. Cleanouts shall be provided at or near the base of the vertical stacks with the cleanout plug located approximately 600 mm (24 inches) above the floor. The cleanouts shall be extended to the wall access cover. Cleanout shall consist of sanitary tees. Nickel bronze square frame and stainless steel cover with minimum opening of 150 mm by 150 mm (6 inch by 6 inch) shall be provided at each wall cleanout.
- C. In horizontal runs above grade, cleanouts shall consist of cast brass tapered screw plug in fitting or caulked/no hub cast iron ferrule. Plain end (no-hub) piping in interstitial space or above ceiling may use plain end (no-hub) blind plug and clamp.

2.4 ROOF DRAINS AND CONNECTIONS

- A. Roof Drains: Roof Drains (RD) shall be cast iron with clamping device for making watertight connection. Free openings through strainer shall be twice area of drain outlet. For roof drains not installed in connection with a waterproof membrane, a soft copper membrane shall be provided 300 mm (12 inches) in diameter greater than outside diameter of drain collar. An integral gravel stop shall be provided for drains

installed on roofs having built up roofing covered with gravel or slag. Integral no-hub, soil pipe gasket or threaded outlet connection shall be provided.

1. Flat Roofs: The roof drain shall have a beehive or dome shaped strainer with integral flange not less than 300 mm (12 inches) in diameter. For an insulated roof, a roof drain with an adjustable drainage collar shall be provided, which can be raised or lowered to meet required insulation heights, sump receiver and deck clamp. The Bottom section shall serve as roof drain during construction before insulation is installed.
 2. Protective Roof Membrane Insulation Assembly: The roof drain shall have a perforated stainless steel extension filter, non puncturing clamp ring, large sump with extra wide roof flange and deck clamp.
 - a. Non pedestrian Roofs: The roof drain shall have large polypropylene or aluminum locking dome.
 - b. Pedestrian Roof: The roof drain shall have a bronze promenade top 350 mm (14 inches) square, set in square secured frame support collar.
 3. Roof Drains, Overflow: Roof Drains identified as overflow drains shall have a 50 mm (2 inch) water dam integral to the drain body.
 4. Roof drains in areas subject to freezing shall have heat tape and shall be insulated.
- B. Expansion Joints: Expansions joints shall be heavy cast iron with cast brass or copper expansion sleeve having smooth bearing surface working freely against a packing ring held in place and under pressure of a bolted gland ring, forming a water and air tight flexible joint. Asbestos packing is prohibited.
- C. Interior Downspouts: An expansion joint shall be provided, specified above, at top of run on straight, vertical runs of downspout piping 12 m (40 feet) long or more.

2.5 WATERPROOFING

- A. A sleeve flashing device shall be provided at points where pipes pass through membrane waterproofed floors or walls. The sleeve flashing device shall be manufactured, cast iron fitting with clamping device that forms a sleeve for the pipe floor penetration of the floor membrane. A galvanized steel pipe extension shall be included in the top of the fitting that will extend 50 mm (2 inches) above finished floor and galvanized steel pipe extension in the bottom of the fitting

that will extend through the floor slab. A waterproofed caulked joint shall be provided at the top hub.

B. Walls: See detail shown on drawings.

PART 3 - EXECUTION

3.1 PIPE INSTALLATION

- A. The pipe installation shall comply with the requirements of the International code and these specifications.
- B. Branch piping shall be installed from the piping system and connect to all drains and outlets.
- C. Pipe shall be round and straight. Cutting shall be done with proper tools. Pipe shall be reamed to full size after cutting.
- D. All pipe runs shall be laid out to avoid interference with other work.
- E. The piping shall be installed above accessible ceilings to allow for ceiling panel removal.
- F. Unless otherwise stated on the documents, minimum horizontal slope shall be one inch for every 1.22 m (4 feet) of pipe length.
- G. The piping shall be installed free of sags and bends.
- H. Seismic restraint shall be installed where required by code.
- I. Changes in direction for storm drainage piping shall be made using appropriate branches, bends and long sweep bends. Sanitary tees and short sweep $\frac{1}{4}$ bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Long turn double wye branch and $\frac{1}{8}$ bend fittings shall be used if two fixtures are installed back to back or side by side with common drain pipe. Do not change direction of flow more than 90 degrees. Proper size of standard increaser and reducers shall be used if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- J. Cast iron piping shall be installed according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings"

3.2 JOINT CONSTRUCTION

- A. Hub and spigot, cast iron piping with gasket joints shall be joined in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

- B. Hub and spigot, cast iron piping with calked joints shall be joined in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
- C. Hubless, cast iron piping shall be joined in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless piping coupling joints.
- D. For threaded joints, thread pipe with tapered pipe threads according to ASME B1.20.1. The threads shall be cut full and clean using sharp disc cutters. Threaded pipe ends shall be reamed to remove burrs and restored to full pipe inside diameter. Pipe fittings and valves shall be joined as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is required by the pipe service
 - 2. Pipe sections with damaged threads shall be replaced with new sections of pipe.

3.3 SPECIALTY PIPE FITTINGS

- A. Transition coupling shall be installed at pipe joints with small differences in pipe outside diameters.
- B. Dielectric fittings shall be installed at connections of dissimilar metal piping and tubing.

3.4 PIPE HANGERS, SUPPORTS AND ACCESSORIES:

- A. All piping shall be supported according to the International plumbing code, Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING, and these specifications.
- B. Hangers, supports, rods, inserts and accessories used for Pipe supports shall be shop coated with zinc Chromate primer paint. Electroplated copper hanger rods, hangers and accessories may be used with copper tubing.
- C. Horizontal piping and tubing shall be supported within 300 mm (12 inches) of each fitting or coupling.
- D. Horizontal cast iron piping shall be supported with the following maximum horizontal spacing and minimum hanger rod diameters:
 - 1. NPS 1-1/2 to NPS 2 (DN 40 to DN 50): 1500 mm (60 inches) with 10 mm (3/8 inch) rod.
 - 2. NPS 3 (DN 80): 1500 mm (60 inches) with 13 mm (1/2 inch) rod.
 - 3. NPS 4 to NPS 5 (DN 100 to DN 125): 1500 mm (60 inches) with 16 mm (5/8 inch) rod.

4. NPS 6 to NPS 8 (DN 150 to DN 200): 1500 mm (60 inches) with 19 mm (3/4 inch) rod.
 5. NPS 10 to NPS 12 (DN 250 to DN 300): 1500 mm (60 inches) with 22 mm (7/8 inch) rod.
- E. The maximum support spacing for horizontal plastic shall be 1.22 m (4 feet).
- F. Vertical piping and tubing shall be supported at the base, at each floor, and at intervals no greater than 4.57 m (15 feet).
- G. In addition to the requirements in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING, floor, Wall and Ceiling Plates shall have the following characteristics:
1. Solid or split unplated cast iron.
 2. All plates shall be provided with set screws.
 3. Height adjustable clevis type pipe hangers.
 4. Adjustable Floor Rests and Base Flanges shall be steel.
 5. Hanger Rods shall be low carbon steel, fully threaded or Threaded at each end with two removable nuts at each end for positioning rod and hanger and locking each in place.
 6. Riser Clamps shall be malleable iron or steel.
 7. Roller shall be cast iron.
 8. Hangers and supports utilized with insulated pipe and tubing shall have 180 degree (min.) metal protection shield Centered on and welded to the hanger and support. The shield shall be 4 inches in length and be 16 gage steel. The shield shall be sized for the insulation.
- H. Miscellaneous Materials shall be provided as specified, required, directed or as noted on the drawings for proper installation of hangers, supports and accessories. If the vertical distance exceeds 6 m (20 feet) for cast iron pipe additional support shall be provided in the center of that span. All necessary auxiliary steel shall be provided to provide that support.
- I. Cast escutcheon with set screw shall be installed at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.

J. Penetrations:

1. Fire Stopping: Where pipes pass through fire partitions, fire walls, smoke partitions, or floors, a fire stop shall be installed that provides an effective barrier against the spread of fire, smoke and gases as specified in Section 07 84 00, FIRESTOPPING. Clearances between raceways and openings shall be completely filled and sealed with the fire stopping materials.
2. Water proofing: At floor penetrations, Clearances around the pipe shall be completely sealed and made watertight with sealant as specified in Section 07 92 00, JOINT SEALANTS.

K. Piping shall conform to the following:

1. Storm Water Drain and Vent Drain to main stacks:

Pipe Size	Minimum Pitch
80 mm (3 inches) and smaller	2%
100 mm (4 inches) (4 inches) and larger	1%

3.5 TESTS

- A. Storm sewer system shall be tested either in its entirety or in sections.
- B. Storm Water Drain tests shall be conducted before trenches are backfilled or fixtures are connected. A water test or air test shall be conducted, as directed.
 1. If entire system is tested with water, tightly close all openings in pipes except the highest opening, and fill system with water to point of overflow. If system is tested in sections, tightly plug each opening except highest opening of section under test, fill each section with water and test with at least a 3 m (10 foot) head of water. In testing successive sections, test at least upper 3 m (10 feet) of next preceding section so that each joint or pipe except upper most 3 m (10 feet) of system has been submitted to a test of at least a 3 m (10 foot) head of water. Water shall be kept in the system, or in portion under test, for at least 15 minutes before inspection starts. System shall then be tight at all joints.

2. For an air test, an air pressure of 35 kPa (5 psi) gage shall be maintained for at least 15 minutes without leakage. A force pump and mercury column gage shall be used for the test.
3. Final Tests: Either one of the following tests may be used.
 - a. Smoke Test: After fixtures are permanently connected and traps are filled with water, fill entire drainage and vent systems with smoke under pressure of 1.3 kPa (1 inch of water) with a smoke machine. Chemical smoke is prohibited.
 - b. Peppermint Test: Introduce .06 liters (2 ounces) of peppermint into each line or stack.

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**SECTION 22 40 00
PLUMBING FIXTURES**

PART 1 - GENERAL

1.1 DESCRIPTION

Plumbing fixtures, associated trim and fittings necessary to make a complete installation from wall or floor connections to rough piping, and certain accessories.

1.2 RELATED WORK

- A. Sealing between fixtures and other finish surfaces: Section 07 92 00, JOINT SEALANTS.
- B. Flush panel access doors: Section 08 31 13, ACCESS DOORS AND FRAMES.
- C. Through bolts: Section 10 21 13, TOILET COMPARTMENTS.
- D. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

1.3 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Submit plumbing fixture information in an assembled brochure, showing cuts and full detailed description of each fixture.

1.4 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American National Standard Institute (ANSI):
The American Society of Mechanical Engineers (ASME):
A112.6.1M-02(R2008).....Floor Affixed Supports for Off-the-Floor
Plumbing Fixtures for Public Use
A112.19.1M-08Enameled Cast Iron Plumbing Fixtures
A112.19.2M-03.....Vitreous China Plumbing Fixtures
A112.19.3-2001(R2008)...Stainless Steel Plumbing Fixtures (Designed for
Residential Use)
- C. American Society for Testing and Materials (ASTM):
A276-2010Stainless and Heat-Resisting Steel Bars and
Shapes
WW-P-541-E/GENPlumbing Fixtures with Amendment 1
- D. National Association of Architectural Metal Manufacturers (NAAMM): NAAMM
AMP 500-505
Metal Finishes Manual (1988)

- E. American Society of Sanitary Engineers (ASSE):
 1016-05.....Performance Requirements for Individual
 Thermostatic, Pressure Balancing and Combination
 Pressure Balancing and Thermostatic Control
 Valves for Individual Fixture Fittings
- F. National Sanitation Foundation (NSF)/American National Standards
 Institute (ANSI):
 61-2009Drinking Water System Components-Health Effects
- G. American with Disabilities Act (A.D.A) Section 4-19.4 Exposed Pipes and
 Surfaces
- H. Environmental Protection Agency EPA PL 93-523 1974; A 1999) Safe
 Drinking Water Act.
- I. International Building Code, ICC IPBC 2009.

PART 2 - PRODUCTS

2.1 STAINLESS STEEL

- A. Corrosion-resistant Steel (CRS):
 - 1. Plate, Sheet and Strip: CRS flat products shall conform to chemical composition requirements of any 300 series steel specified in ASTM A276.
 - 2. Finish: Exposed surfaces shall have standard polish (ground and polished) equal to NAAMM finish Number 4.
- B. Die-cast zinc alloy products are prohibited.

2.2 STOPS

- A. Provide lock-shield loose key or screw driver pattern angle stops, straight stops or stops integral with faucet, with each compression type faucet whether specifically called for or not, including sinks in wood and metal casework, laboratory furniture and pharmacy furniture. Locate stops centrally above or below fixture in accessible location.
- B. Furnish keys for lock shield stops to Contracting Officer Technical Representative.
- C. Supply from stops not integral with faucet shall be chrome plated copper flexible tubing or flexible stainless steel with inner core of non-toxic polymer.
- D. Supply pipe from wall to valve stop shall be rigid threaded IPS copper alloy pipe, i.e. red brass pipe nipple, chrome plated where exposed.

2.3 ESCUTCHEONS

Heavy type, chrome plated, with set screws. Provide for piping serving plumbing fixtures and at each wall, ceiling and floor penetrations in exposed finished locations and within cabinets and millwork.

2.4 LAMINAR FLOW CONTROL DEVICE

- A. Smooth, bright stainless steel or satin finish, chrome plated metal laminar flow device shall provide non-aeration, clear, coherent laminar flow that will not splash in basin. Device shall also have a flow control restrictor and have vandal resistant housing.
- B. Flow Control Restrictor:
 - 1. Capable of restricting flow to 32 ml/s (0.5 gpm) for lavatories and for sink p-524; and 170 ml/s to 190 ml/s (2.75 gpm to 3.0 gpm) for dietary food preparation and rinse sinks or as specified.
 - 2. Compensates for pressure fluctuation maintaining flow rate specified above within 10 percent between 170 kPa and 550 kPa (25 psi and 80 psi).
 - 3. Operates by expansion and contraction, eliminates mineral/sediment build-up with self-cleaning action, and is capable of easy manual cleaning.

2.5 CARRIERS

- A. ASME/ANSI A112.6.1M, with adjustable gasket faceplate chair carriers for wall hung closets with auxiliary anchor foot assembly, hanger rod support feet, and rear anchor tie down. Extra heavy duty, rated for 1,000 pound static load.
- B. ASME/ANSI A112.6.1M, lavatory, chair carrier for thin wall construction. All lavatory chair carriers shall be capable of supporting the lavatory with a 250-pound vertical load applied at the front of the fixture.
- C. Where water closets, lavatories or sinks are installed back-to-back and carriers are specified, provide one carrier to serve both fixtures in lieu of individual carriers. The drainage fitting of the back to back carrier shall be so constructed that it prevents the discharge from one fixture from flowing into the opposite fixture.

2.6 WATER CLOSETS

- A. (P-103) Water Closet (Wall Hung, ASME/ANSI A112.19.2M, Figure 9) office and industrial, elongated bowl, siphon jet 6 L (1.6 gallons) per flush, wall outlet. Top of rim shall be between 406 mm and 432 mm (16 inches and 17 inches) above finished floor. Handicapped water closet shall have rim set 457 mm (18 inches) above finished floor.
 - 1. Seat: Institutional/Industrial, extra heavy duty, chemical resistant, solid plastic, open front less cover for elongated bowls, integrally molded bumpers, concealed check hinge with stainless steel post. Seat shall be posture contoured body design. Color shall be white.
 - 2. Fittings and Accessories: Gaskets - neoprene; bolts with chromium plated caps nuts and washers.

3. Flush valve: Large chloramines resistant diaphragm, semi-red brass valve body, exposed chrome plated, hardwired active infra-red sensor for automatic operation with courtesy flush button for manual operation water saver design 6 L (1.6 gallons) per flush with maximum 10 percent variance, 25 mm (1 inch) screwdriver back check angle stop with vandal resistant cap, adjustable tailpiece, a high back pressure vacuum breaker, spud coupling for 38 mm (1 1/2 inches) top spud, wall and spud flanges, and sweat solder adapter with cover tube and set screw wall flange. Valve body, cover, tailpiece and control stop shall be in conformance with ASTM alloy classification for semi-red brass. Seat bumpers shall be integral part of flush valve. Set centerline of inlet 292 mm (11 1/2 inches) above rim.

2.7 URINALS

- A. (P-203) Urinal (Wall hung ASME/ANSI A112.19.2M) bowl with washout flush action, wall to front flare 356 mm (14 inches). Vitreous china, wall hung with integral trap 4L (1.0 gallons) per flush with 51 mm (2 inches) back outlet and 19 mm (3/4 inch) back spud inlet. Flush valve 290 mm (11 1/2 inches) above urinal.
 1. Support urinal with chair carrier and install with rim at 600 mm (24 inches) above finished floor.
 2. Flushing device: Large chloramines resistant diaphragm, semi-red brass valve body, exposed chrome plated, hardwired active infra-red sensor for automatic operation with courtesy flush button for manual operation water saver design 6 L (1.6 gallons) per flush with maximum 10 percent variance, 25 mm (1 inch) screwdriver back check angle stop with vandal resistant cap, adjustable tailpiece, a high back pressure vacuum breaker, spud coupling for 38 mm (1 1/2 inches) top spud, wall and spud flanges, and sweat solder adapter with cover tube and set screw wall flange. Valve body, cover, tailpiece and control stop shall be in conformance with ASTM alloy classification for semi-red brass.

2.8 LAVATORIES

- A. Dimensions for lavatories are specified, length by width (distance from wall) and depth.
- B. Brass components in contact with water shall contain no more than 3 percent lead content by dry weight.

- C. (P-404) Lavatory (Integral with Countertop) Lavatory is integral to solid surface counter, refer to architectural specifications:
1. Faucet: Solid cast brass construction, chrome plated, cast arched faucet spout 102 by 127 mm (4 to 5 inches) above the rim, electronic sensor operated, four-inch center set mounting, wiring box, 120/24 volt solenoid, remote mounted transformer, and thermostatic mixing valve. Provide laminar flow control device. Maximum 0.5 gallons per minute flow rate.
 2. Valve: Type T/P combination thermostatic and pressure balancing with lever operating handle. Valve body shall be copper alloy. Internal parts shall be copper, nickel alloy, CRS or thermostatic material. Valve inlet and outlet shall be 13 mm (1/2 inch) IPS. Provide external screwdriver checkstops and temperature limit stop. Set stops for a maximum temperature of 35 degrees C (95 degrees F). Shall meet ASSE 1016.
 3. Drain: Cast or wrought brass with flat grid strainer and offset tailpiece, chrome plated finish.
 4. Stops: Angle type. See paragraph 2.2. Stops
 5. Trap: Cast copper alloy, 38 mm by 32 mm (1 1/2 inches by 1 1/4 inches) P-trap. Adjustable with connected elbow and 1.4 mm thick (17 gauge) tubing extension to wall. Exposed metal trap surface and connection hardware shall be chrome plated with a smooth bright finish. Set trap parallel to wall.
 6. Provide cover for drain, stops and trap per A.D.A 4-19.4.
- D. (P-418) Lavatory (Sensor Control, Gooseneck Spout, ASME/ANSI A112.19.2M, Figure 16) straight back, approximately 508 mm by 457 mm (20 inches by 18 inches) and a 102 mm (4 inches) minimum apron, first quality vitreous china with punching for gooseneck spout. Set rim 864 mm (34 inches) above finished floor. Maximum 0.5 gallons per minute flow rate.
1. Faucet: Solid cast brass construction, chrome plated, gooseneck spout with outlet 102 mm to 127 mm (4 inches to 5 inches) above rim. Electronic sensor operated, 102 mm (4 inches) center set mounting, wiring box, 120/24 volt solenoid, remote mounted transformer, back check valves. Provide laminar flow control device. Breaking the light beam shall activate the water flow. Flow shall stop when user moves away from light beam. All connecting wiring between transformer, solenoid valve and sensor shall be cut to length with no excess hanging or wrapped up wiring allowed.

2. Valve: Type T/P combination thermostatic and pressure balancing with lever operating handle. Valve body shall be copper alloy. Internal parts shall be copper, nickel alloy, CRS or thermostatic material. Valve inlet and outlet shall be 13 mm (1/2 inch) IPS. Provide external screwdriver checkstops and temperature limit stop. Set stops for a maximum temperature of 35 degrees C (95 degrees F). Shall meet ASSE 1016.
3. Drain: Cast or wrought brass with flat grid strainer with offset tailpiece, brass, chrome plated.
4. Stops: Angle type. See paragraph 2.2.Stops
5. Trap: Cast copper alloy, 38 mm by 32 mm (1 1/2 inches by 1 1/4 inches)P-trap. Adjustable with connected elbow and 17 gage tubing extension to wall. Exposed metal trap surface and connection hardware shall be chrome plated with a smooth bright finish. Set trap parallel to wall.
6. Provide cover for drain, stops and trap per A.D.A 4-19.4.

2.9 SINKS AND LAUNDRY TUBS

- A. Dimensions for sinks and laundry tubs are specified, length by width (distance from wall) and depth.
 - B. (P-502) Service Sink (Corner, Floor Mounted) stain resistant terrazzo, 711 mm by 711 mm by 305 mm (28 inches by 28 inches by 12 inches) with 152 mm (6 inches) drop front. Terrazzo, composed of marble chips and white Portland cement, shall develop compressive strength of 20684 kPa (3000 psi) seven days after casting. Provide extruded aluminum cap on front side.
1. Faucet: Solid brass construction, combination faucet with replaceable monel seat, removable replacement unit containing all parts subject to wear, integral stops, mounted on wall above sink. Spout shall have a pail hook, 19 mm (3/4 inch) hose coupling threads, vacuum breaker, and top or bottom brace to wall. Four-arm handles on faucets shall be cast, formed, or drop forged copper alloy. Escutcheons shall be either forged copper alloy or CRS. Exposed metal parts, including exposed part under valve handle when in open position, shall have a smooth bright finish. Provide 914 mm (36 inches) hose with wall hook. Centerline of rough in is 1219 mm (48 inches) above finished floor.
 2. Drain: Seventy six millimeter (3 inches) cast brass drain with nickel bronze strainer.
 3. Trap: P-trap, drain through floor.

C. (P-524) Sink, (CRS, Double Compartment, Counter Top, ASME/ANSI A112.19.3M, Kitchen Sinks, Figure 6) self rimming, approximately 838 mm by 559 mm (33 inches by 22 inches) with two compartments inside dimensions approximately 343 mm by 406 mm by 191 mm (13 1/2 inches by 16 inches by 7 1/2 inches), minimum 20 gage CRS. Corners and edges shall be well rounded.

1. Faucet: Kitchen sink, solid brass construction, swing spout, chrome plated copper alloy with spray and hose.
2. Drain: Drain plug with cup strainer, stainless steel.
3. Trap: Cast copper alloy, 38 mm (1 1/2 inches) P-trap with cleanout plug, continuous drain with wall connection and escutcheon.
4. Provide cover for drain, stops and trap per A.D.A 4-19.4.

2.10 DISPENSER, DRINKING WATER

- A. Standard rating conditions: 10 degrees C (50 degrees F) water with 27 degrees C (80 degrees F) inlet water temperature and 32 degrees C (90 degrees F) ambient air temperature.
- B. (P-610) Electric Water Cooler: Barrier-free units. Two-level, stainless steel water cooler with contoured basins, tubular support arms, and recessed refrigeration system with removable louvered stainless steel grille. Water-bearing materials shall be in compliance with Safe Drinking Water Act of 1986, and Lead Contamination Control Act of 1988. Condensing unit shall be quiet operating, reciprocating compressor, hermetically sealed, self-contained, complete with service valves. Controls shall include adjustable thermostat to activate switch for controlling water temperature, capillary tube, or expansion valve for refrigerant expansion, and hand-operated rugged supply valve. Two separate metal walls between waste water and fresh water supply and between refrigerant and drinking water. Units shall operate on 120 volt AC, 60 hertz, single phase. Electric cords, 3 wire, with Russellstoll plugs No. 8593CTN or 8593UICT.

2.11 HYDRANT, HOSE BIBB AND MISCELLANEOUS DEVICES

- A. Point-of-Use Three Way Mixing Valve
 1. In accordance with ASSE 1016.
 2. With temperature adjustment range from 60 degrees F to 115 degrees F, and having brass body with polished chrome finish, wax or liquid filled thermostatic motor, tamper-resistant temperature adjustment control, self-aligning bronze trim, and combination strainer/checkstops.

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Fixture Setting: Opening between fixture and floor and wall finish shall be sealed as specified under Section 07 92 00, JOINT SEALANTS.
- B. Supports and Fastening: Secure all fixtures, equipment and trimmings to partitions, walls and related finish surfaces. Exposed heads of bolts and nuts in finished rooms shall be hexagonal, polished chrome plated brass with rounded tops.
- C. Through Bolts: For free standing marble and metal stud partitions refer to Section 10 21 13, TOILET COMPARTMENTS.
- D. Toggle Bolts: For hollow masonry units, finished or unfinished.
- E. Expansion Bolts: For brick or concrete or other solid masonry. Shall be 6 mm (1/4 inch) diameter bolts, and to extend at least 76 mm (3 inches) into masonry and be fitted with loose tubing or sleeves extending into masonry. Wood plugs, fiber plugs, lead or other soft metal shields are prohibited.
- F. Power Set Fasteners: May be used for concrete walls, shall be 6 mm (1/4 inch) threaded studs, and shall extend at least 32 mm (1 1/4 inches) into wall.
- G. Tightly cover and protect fixtures and equipment against dirt, water and chemical or mechanical injury.
- H. Where water closet waste pipe has to be offset due to beam interference, provide correct and additional piping necessary to eliminate relocation of water closet.
- I. Do not use aerators on lavatories and sinks.

3.2 CLEANING

At completion of all work, fixtures, exposed materials and equipment shall be thoroughly cleaned.

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**SECTION 22 42 26
COMMERCIAL DISPOSERS**

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies food waste machines as follows:

1. Food waste disposers.

1.2 RELATED WORK

A. Other sections containing FOODSERVICE EQUIPMENT

1. Division 11, Section 11 40 11

B. Electrical Connections: Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW).

C. Electrical Disconnect Switches: Section 26 29 21, DISCONNECT SWITCHES.

D. SECTION 22 08 00 - COMMISSIONING OF PLUMBING SYSTEMS.

Requirements for commissioning, systems readiness checklist, and training.

1.3 QUALITY CONTROL

A. Installer Qualifications: Licensed electrician and plumber experienced with food service equipment installation or supervised by an experienced food service equipment installer.

B. NSF Compliance: Equipment bears NSF Certification Mark or UL Classification Mark indicating compliance with NSF/ANSI 13 - 2009.

C. UL Listing: Equipment is evaluated according to UL 430 and listed in UL's "Heating, Cooling, Ventilating and Cooking Equipment Directory" and labeled for intended use.

1. Products that contain features, characteristics, components, materials, or systems different from those covered by UL 430 shall be evaluated by UL using appropriate additional component and end-product requirements to maintain the level of safety anticipated by the intent of UL 430.

D. Welding: Perform welding according to AWS D9.1M/D9.1. - 2006.

E. Provide appliances that earn and bear the ENERGY STAR and meet the ENERGY STAR specifications for energy efficiency, where applicable. See http://www.energystar.gov/index.cfm?c=commercial_food_service.

1.4 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data:
 - 1. Include manufacturer's address and telephone number.
 - 2. Include catalog or model numbers, illustrations and descriptions of food waste machines and accessories.
- C. Installation Drawings: Show dimensions; method of assembly; and details of installation, adjoining construction, coordination with plumbing and electrical work, and other work required for a complete installation.
- D. Operating Instructions: Comply with requirements in .

1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Welding Society (AWS):
 - D9.1M/D9.1-2006Sheet Metal Welding Code
- C. NSF International/American National Standards Institute (NSF/ANSI):
 - 13-2009Refuse Processors and Processing Systems
- D. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA): Document 1767: Kitchen Ventilation Systems and Food Service Equipment Guidelines, 2001.
- E. Underwriters Laboratories Inc. (UL):
 - 430.....Waste Disposers
- F. UL Heating, Cooling, Ventilating and Cooking Equipment Directory

PART 2 - PRODUCTS**2.1 FOOD WASTE DISPOSER**

- A. Food Waste Disposer Unit:
 - 1. Corrosion-proof construction housing and dual-direction shredding elements.
 - 2. Flow control.
 - 3. Solenoid valve.
 - 4. Vacuum breaker.
 - 5. Fixed nozzle.
- B. Motor:
 - 1. TEFC Motor (Totally Enclosed Fan Cooled) Construction.
 - 2. Built-In Thermal Overload Protection.
 - 3. Bearings sealed and lubricated.

C. Control Panel:

1. Autoreversing and internal time water flush.
2. Stainless-steel mounting bracket.

D. Overhead Spray:

1. Backsplash mounted with hot- and cold-water mixing valve.
2. Wall support bracket.
3. Flexible 10 mm (3/8 inch) metal-encased hose supported by spiral spring, minimum length 737 mm (29 inches).
4. Spray head assembly with lockable lever handle.
5. Exposed metal parts are chrome plated or stainless steel.

E. Accessories:

1. Collar adaptor for trough.
2. Cone with adaptor ring.
3. Cone cover.

2.2 UNIT SPECIFICATIONS

ITEM #15 DISPOSER AND CONTROL (5 H.P.)

1. Per section 2.1 above.
2. Fully integrated with item #17
3. Basis of Design: In-Sink-Erator SS-500-6-AS101

ITEM #26 DISPOSER AND CONTROL (5 H.P.)

1. Per section 2.1 above.
2. Fully integrated with item #27
3. Basis of Design: In-Sink-Erator SS-500-6-AS101

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install food waste machines, including controls and accessory equipment, arranged for safe and convenient operation and maintenance.
- B. Install food waste machines to prevent backflow of polluted water or waste into water supply system or on to food preparation work surfaces.
- C. Install and interconnect electrical controls and switches.
- D. Set timer to run 15 seconds after disposer stop.
- E. Install under-sink controls fully recessed to minimize bumping into controls.

3.2 PROTECTING AND CLEANING

- A. Protect equipment from dirt, water, and chemical or mechanical injury during the remainder of the construction period.

- B. At completion of work, clean, lubricate, and adjust food waste disposers as required to produce ready-for-use condition.
 - 1. Where stainless-steel surfaces are damaged during food waste disposer installation procedures, repair finishes to match adjoining undamaged surfaces.

3.3 INSTRUCTIONS

Instruct personnel and transmit operating instructions in accordance with requirements in.

3.4 COMMISSIONING

- A. Provide commissioning documentation in accordance with the requirements of Section 22 08 00 - COMMISSIONING OF PLUMBING SYSTEMS for all inspection, startup, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 22 08 00 - COMMISSIONING OF PLUMBING SYSTEMS and related sections for contractor responsibilities for system commissioning.

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**SECTION 23 05 11
COMMON WORK RESULTS FOR HVAC**

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The requirements of this Section apply to all sections of Division 23.
- B. Definitions:
 - 1. Exposed: Piping, ductwork, and equipment exposed to view in finished rooms.
 - 2. Option or optional: Contractor's choice of an alternate material or method.
 - 3. COR: Contracting Officer's Representative.

1.2 RELATED WORK

- A. Section 01 00 00, GENERAL REQUIREMENTS
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES
- C. Section 03 30 00, CAST-IN-PLACE CONCRETE: Concrete and Grout
- D. Section 07 84 00, FIRESTOPPING
- E. Section 07 60 00, FLASHING AND SHEET METAL: Flashing for Wall and Roof Penetrations
- F. Section 07 92 00, JOINT SEALANTS
- G. Section 09 91 00, PAINTING
- H. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION
- I. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT
- J. Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC
- K. Section 23 07 11, HVAC, PLUMBING, and Boiler Plant Insulation
- L. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC
- M. Section 23 11 23, FACILITY NATURAL-GAS PIPING
- N. Section 23 21 13, HYDRONIC PIPING
- O. Section 23 22 13, STEAM and CONDENSATE HEATING PIPING
- P. Section 23 25 00, HVAC WATER TREATMENT
- Q. Section 23 31 00, HVAC DUCTS and CASINGS
- R. Section 23 34 00, HVAC FANS
- S. Section 23 36 00, AIR TERMINAL UNITS
- T. Section 23 37 00, AIR OUTLETS and INLETS
- U. Section 23 40 00, HVAC AIR CLEANING DEVICES
- V. Section 23 73 00, INDOOR CENTRAL-STATION AIR-HANDLING UNITS
- W. Section 23 74 13, PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS
- X. Section 23 82 16, AIR COILS

- Y. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS: Requirements for commissioning, systems readiness checklists, and training
- Z. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS
- AA. Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS

1.3 QUALITY ASSURANCE

- A. Mechanical, electrical and associated systems shall be safe, reliable, efficient, durable, easily and safely operable and maintainable, easily and safely accessible, and in compliance with applicable codes as specified. The systems shall be comprised of high quality institutional-class and industrial-class products of manufacturers that are experienced specialists in the required product lines. All construction firms and personnel shall be experienced and qualified specialists in industrial and institutional HVAC.
- B. Flow Rate Tolerance for HVAC Equipment: Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.
- C. Equipment Vibration Tolerance:
 - 1. Refer to Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT. Equipment shall be factory-balanced to this tolerance and re-balanced on site, as necessary.
 - 2. After HVAC air balance work is completed and permanent drive sheaves are in place, perform field mechanical balancing and adjustments required to meet the specified vibration tolerance.
- D. Products Criteria:
 - 1. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 3 years (or longer as specified elsewhere). The design, model and size of each item shall have been in satisfactory and efficient operation on at least three installations for approximately three years. However, digital electronics devices, software and systems such as controls, instruments, computer work station, shall be the current generation of technology and basic design that has a proven satisfactory service record of at least three years. See other specification sections for any exceptions and/or additional requirements.
 - 2. All items furnished shall be free from defects that would adversely affect the performance, maintainability and appearance of individual components and overall assembly.

3. Conform to codes and standards as required by the specifications. Conform to local codes, if required by local authorities such as the natural gas supplier, if the local codes are more stringent than those specified. Refer any conflicts to the Contracting Officer's Representative.
4. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.
5. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.
6. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped or otherwise permanently marked on each item of equipment.
7. Asbestos products or equipment or materials containing asbestos shall not be used.

E. Equipment Service Organizations:

1. HVAC: Products and systems shall be supported by service organizations that maintain a complete inventory of repair parts and provide response time of 4 hours for emergency service and 24 hours for non-emergency notifications.

F. HVAC Mechanical Systems Welding: Before any welding is performed, contractor shall submit a certificate certifying that welders comply with the following requirements:

1. Qualify welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualifications".
2. Comply with provisions of ASME B31 series "Code for Pressure Piping".
3. Certify that each welder has passed American Welding Society (AWS) qualification tests for the welding processes involved, and that certification is current.

G. Execution (Installation, Construction) Quality:

1. Apply and install all items in accordance with manufacturer's written instructions. Refer conflicts between the manufacturer's instructions and the contract drawings and specifications to the Contracting Officer's Representative for resolution. Provide written hard copies or computer files of manufacturer's installation instructions

to the Contracting Officer's Representative at least two weeks prior to commencing installation of any item. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations is a cause for rejection of the material.

2. Provide complete layout drawings required by Paragraph, SUBMITTALS. Do not commence construction work on any system until the layout drawings have been approved.

H. Upon request by Government, provide lists of previous installations for selected items of equipment. Include contact persons who will serve as references, with telephone numbers and e-mail addresses.

1.4 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, and with requirements in the individual specification sections.
- B. Contractor shall make all necessary field measurements and investigations to assure that the equipment and assemblies will meet contract requirements.
- C. If equipment is submitted which differs in arrangement from that shown, provide drawings that show the rearrangement of all associated systems. Approval will be given only if all features of the equipment and associated systems, including accessibility, are equivalent to that required by the contract.
- D. Prior to submitting shop drawings for approval, contractor shall certify in writing that manufacturers of all major items of equipment have each reviewed drawings and specifications, and have jointly coordinated and properly integrated their equipment and controls to provide a complete and efficient installation.
- E. Submittals and shop drawings for interdependent items, containing applicable descriptive information, shall be furnished together and complete in a group. Coordinate and properly integrate materials and equipment in each group to provide a completely compatible and efficient.
- F. Layout Drawings:
 1. Submit complete consolidated and coordinated layout drawings for all new systems, and for existing systems that are in the same areas. Refer to Section 01 00 00, GENERAL REQUIREMENTS.
 2. The drawings shall include plan views, elevations and sections of all systems and shall be on a scale of not less than 1:32 (3/8-inch equal to one foot). Clearly identify and dimension the proposed locations of the principal items of equipment. The drawings shall clearly show

- locations and adequate clearance for all equipment, piping, valves, control panels and other items. Show the access means for all items requiring access for operations and maintenance. Provide detailed layout drawings of all piping and duct systems.
3. Do not install equipment foundations, equipment or piping until layout drawings have been approved.
 4. In addition, for HVAC systems, provide details of the following:
 - a. Mechanical equipment rooms.
 - b. Hangers, inserts, supports, and bracing.
 - c. Pipe sleeves.
 - d. Duct or equipment penetrations of floors, walls, ceilings, or roofs.
- G. Manufacturer's Literature and Data: Submit under the pertinent section rather than under this section.
1. Submit belt drive with the driven equipment. Submit selection data for specific drives when requested by the Contracting Officer's Representative.
 2. Submit electric motor data and variable speed drive data with the driven equipment.
 3. Equipment and materials identification.
 4. Fire-stopping materials.
 5. Hangers, inserts, supports and bracing. Provide load calculations for variable spring and constant support hangers.
 6. Wall, floor, and ceiling plates.
- H. HVAC Maintenance Data and Operating Instructions:
1. Maintenance and operating manuals in accordance with Section 01 00 00, GENERAL REQUIREMENTS, Article, INSTRUCTIONS, for systems and equipment.
 2. Provide a listing of recommended replacement parts for keeping in stock supply, including sources of supply, for equipment. Include in the listing belts for equipment: Belt manufacturer, model number, size and style, and distinguished whether of multiple belt sets.
- I. Provide copies of approved HVAC equipment submittals to the Testing, Adjusting and Balancing Subcontractor.

1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

- B. Air Conditioning, Heating and Refrigeration Institute (AHRI):
430-2009.....Central Station Air-Handling Units
- C. American National Standard Institute (ANSI):
B31.1-2007.....Power Piping
- D. Rubber Manufacturers Association (ANSI/RMA):
IP-20-2007.....Specifications for Drives Using Classical
V-Belts and Sheaves
IP-21-2009.....Specifications for Drives Using Double-V
(Hexagonal) Belts
IP-22-2007.....Specifications for Drives Using Narrow V-Belts
and Sheaves
- E. Air Movement and Control Association (AMCA):
410-96.....Recommended Safety Practices for Air Moving
Devices
- F. American Society of Mechanical Engineers (ASME):
Boiler and Pressure Vessel Code (BPVC):
Section I-2007.....Power Boilers
Section IX-2007.....Welding and Brazing Qualifications
Code for Pressure Piping:
B31.1-2007.....Power Piping
- G. American Society for Testing and Materials (ASTM):
A36/A36M-08.....Standard Specification for Carbon Structural
Steel
A575-96(2007).....Standard Specification for Steel Bars, Carbon,
Merchant Quality, M-Grades
E84-10.....Standard Test Method for Surface Burning
Characteristics of Building Materials
E119-09c.....Standard Test Methods for Fire Tests of Building
Construction and Materials
- H. Manufacturers Standardization Society (MSS) of the Valve and Fittings
Industry, Inc:
SP-58-2009.....Pipe Hangers and Supports-Materials, Design and
Manufacture, Selection, Application, and
Installation
SP 69-2003.....Pipe Hangers and Supports-Selection and
Application
- I. National Electrical Manufacturers Association (NEMA):
MG-1-2009.....Motors and Generators

J. National Fire Protection Association (NFPA):

54-09.....National Fuel Gas Code

70-08.....National Electrical Code

90A-09.....Standard for the Installation of Air
Conditioning and Ventilating Systems

101-09.....Life Safety Code

1.6 DELIVERY, STORAGE AND HANDLING

A. Protection of Equipment:

1. Equipment and material placed on the job site shall remain in the custody of the Contractor until phased acceptance, whether or not the Government has reimbursed the Contractor for the equipment and material. The Contractor is solely responsible for the protection of such equipment and material against any damage.
2. Place damaged equipment in first class, new operating condition; or, replace same as determined and directed by the Contracting Officer's Representative. Such repair or replacement shall be at no additional cost to the Government.
3. Protect interiors of new equipment and piping systems against entry of foreign matter. Clean both inside and outside before painting or placing equipment in operation.
4. Existing equipment and piping being worked on by the Contractor shall be under the custody and responsibility of the Contractor and shall be protected as required for new work.

B. Cleanliness of Piping and Equipment Systems:

1. Exercise care in storage and handling of equipment and piping material to be incorporated in the work. Remove debris arising from cutting, threading and welding of piping.
2. Piping systems shall be flushed, blown or pigged as necessary to deliver clean systems.
3. Clean interior of all tanks prior to delivery for beneficial use by the Government.
4. Boilers shall be left clean following final internal inspection by Government insurance representative or inspector.
5. Contractor shall be fully responsible for all costs, damage, and delay arising from failure to provide clean systems.

1.7 JOB CONDITIONS - WORK IN EXISTING BUILDING

- A. Building Operation: Government employees will be continuously operating and managing all facilities, including temporary facilities, that serve the medical center.

- B. Maintenance of Service: Schedule all work to permit continuous service as required by the medical center.
- C. Steam and Condensate Service Interruptions: Limited steam and condensate service interruptions, as required for interconnections of new and existing systems, will be permitted by the Contracting Officer's Representative during periods when the demands are not critical to the operation of the medical center. These non-critical periods are limited to between 8 pm and 5 am in the appropriate off-season (if applicable).
Provide at least one week advance notice to the Contracting Officer's Representative.
- D. Phasing of Work: Comply with all requirements shown on drawings or specified.
- E. Building Working Environment: Maintain the architectural and structural integrity of the building and the working environment at all times. Maintain the interior of building at 18 degrees C (65 degrees F) minimum. Limit the opening of doors, windows or other access openings to brief periods as necessary for rigging purposes. No storm water or ground water leakage permitted. Provide daily clean-up of construction and demolition debris on all floor surfaces and on all equipment being operated by VA.
- F. Acceptance of Work for Government Operation: As new facilities are made available for operation and these facilities are of beneficial use to the Government, inspections will be made and tests will be performed. Based on the inspections, a list of contract deficiencies will be issued to the Contractor. After correction of deficiencies as necessary for beneficial use, the Contracting Officer will process necessary acceptance and the equipment will then be under the control and operation of Government personnel.
- G. Temporary Facilities: Refer to Article, TEMPORARY PIPING AND EQUIPMENT in this section.

PART 2 - PRODUCTS

2.1 FACTORY-ASSEMBLED PRODUCTS

- A. Provide maximum standardization of components to reduce spare part requirements.
- B. Manufacturers of equipment assemblies that include components made by others shall assume complete responsibility for final assembled unit.
 - 1. All components of an assembled unit need not be products of same manufacturer.
 - 2. Constituent parts that are alike shall be products of a single manufacturer.

3. Components shall be compatible with each other and with the total assembly for intended service.
4. Contractor shall guarantee performance of assemblies of components, and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly.
- C. Components of equipment shall bear manufacturer's name and trademark, model number, serial number and performance data on a name plate securely affixed in a conspicuous place, or cast integral with, stamped or otherwise permanently marked upon the components of the equipment.
- D. Major items of equipment, which serve the same function, must be the same make and model. Exceptions will be permitted if performance requirements cannot be met.

2.2 COMPATIBILITY OF RELATED EQUIPMENT

Equipment and materials installed shall be compatible in all respects with other items being furnished and with existing items so that the result will be a complete and fully operational plant that conforms to contract requirements.

2.3 BELT DRIVES

- A. Type: ANSI/RMA standard V-belts with proper motor pulley and driven sheave. Belts shall be constructed of reinforced cord and rubber.
- B. Dimensions, rating and selection standards: ANSI/RMA IP-20 and IP-21.
- C. Minimum Horsepower Rating: Motor horsepower plus recommended ANSI/RMA service factor (not less than 20 percent) in addition to the ANSI/RMA allowances for pitch diameter, center distance, and arc of contact.
- D. Maximum Speed: 25 m/s (5000 feet per minute).
- E. Adjustment Provisions: For alignment and ANSI/RMA standard allowances for installation and take-up.
- F. Drives may utilize a single V-Belt (any cross section) when it is the manufacturer's standard.
- G. Multiple Belts: Matched to ANSI/RMA specified limits by measurement on a belt measuring fixture. Seal matched sets together to prevent mixing or partial loss of sets. Replacement, when necessary, shall be an entire set of new matched belts.
- H. Sheaves and Pulleys:
 1. Material: Pressed steel, or close grained cast iron.
 2. Bore: Fixed or bushing type for securing to shaft with keys.
 3. Balanced: Statically and dynamically.
 4. Groove spacing for driving and driven pulleys shall be the same.

I. Drive Types, Based on ARI 435:

1. Provide adjustable-pitch drive as follows:
 - a. Fan speeds up to 1800 RPM: 7.5 kW (10 horsepower) and smaller.
 - b. Fan speeds over 1800 RPM: 2.2 kW (3 horsepower) and smaller.
2. Provide fixed-pitch drives for drives larger than those listed above.
3. The final fan speeds required to just meet the system CFM and pressure requirements, without throttling, shall be determined by adjustment of a temporary adjustable-pitch motor sheave or by fan law calculation if a fixed-pitch drive is used initially.

2.4 DRIVE GUARDS

- A. For machinery and equipment, provide guards as shown in AMCA 410 for belts, chains, couplings, pulleys, sheaves, shafts, gears and other moving parts regardless of height above the floor to prevent damage to equipment and injury to personnel. Drive guards may be excluded where motors and drives are inside factory fabricated air handling unit casings.
- B. Pump shafts and couplings shall be fully guarded by a sheet steel guard, covering coupling and shaft but not bearings. Material shall be minimum 16-gage sheet steel; ends shall be braked and drilled and attached to pump base with minimum of four 6 mm (1/4-inch) bolts. Reinforce guard as necessary to prevent side play forcing guard onto couplings.
- C. V-belt and sheave assemblies shall be totally enclosed, firmly mounted, non-resonant. Guard shall be an assembly of minimum 22-gage sheet steel and expanded or perforated metal to permit observation of belts. 25 mm (one-inch) diameter hole shall be provided at each shaft centerline to permit speed measurement.
- D. Materials: Sheet steel, cast iron, expanded metal or wire mesh rigidly secured so as to be removable without disassembling pipe, duct, or electrical connections to equipment.
- E. Access for Speed Measurement: 25 mm (One inch) diameter hole at each shaft center.

2.5 LIFTING ATTACHMENTS

Provide equipment with suitable lifting attachments to enable equipment to be lifted in its normal position. Lifting attachments shall withstand any handling conditions that might be encountered, without bending or distortion of shape, such as rapid lowering and braking of load.

2.6 ELECTRIC MOTORS

All material and equipment furnished and installation methods shall conform to the requirements of Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT; Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS; and, Section 26 05 21, LOW-VOLTAGE

ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW). Provide all electrical wiring, conduit, and devices necessary for the proper connection, protection and operation of the systems. Provide special energy efficient premium efficiency type motors as scheduled.

2.7 VARIABLE SPEED MOTOR CONTROLLERS

- A. Refer to Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS and Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS for specifications.
- B. The combination of controller and motor shall be provided by the manufacturer of the driven equipment, such as pumps and fans, and shall be rated for 100 percent output performance. Multiple units of the same class of equipment, i.e. air handlers, fans, pumps, shall be product of a single manufacturer.
- C. Motors shall be premium efficiency type and be approved by the motor controller manufacturer. The controller-motor combination shall be guaranteed to provide full motor nameplate horsepower in variable frequency operation. Both driving and driven motor/fan sheaves shall be fixed pitch.
- D. Controller shall not add any current or voltage transients to the input AC power distribution system, DDC controls, sensitive medical equipment, etc., nor shall be affected from other devices on the AC power system.
- E. Controller shall be provided with the following operating features and accessories:
 - 1. Suitable for variable torque load.
 - 2. Provide thermal magnetic circuit breaker or fused switch with external operator and incoming line fuses.

2.8 EQUIPMENT AND MATERIALS IDENTIFICATION

- A. Use symbols, nomenclature and equipment numbers specified, shown on the drawings and shown in the maintenance manuals. Identification for piping is specified in Section 09 91 00, PAINTING.
- B. Interior (Indoor) Equipment: Engraved nameplates, with letters not less than 48 mm (3/16-inch) high of brass with black-filled letters, or rigid black plastic with white letters specified in Section 09 91 00, PAINTING permanently fastened to the equipment. Identify unit components such as coils, filters, fans, etc.
- C. Exterior (Outdoor) Equipment: Brass nameplates, with engraved black filled letters, not less than 48 mm (3/16-inch) high riveted or bolted to the equipment.

D. Control Items: Label all temperature and humidity sensors, controllers and control dampers. Identify and label each item as they appear on the control diagrams.

E. Valve Tags and Lists:

1. HVAC and Boiler Plant: Provide for all valves other than for equipment in Section 23 82 00, CONVECTION HEATING AND COOLING UNITS.
2. Valve tags: Engraved black filled numbers and letters not less than 13 mm (1/2-inch) high for number designation, and not less than 6.4 mm (1/4-inch) for service designation on 19 gage 38 mm (1-1/2 inches) round brass disc, attached with brass "S" hook or brass chain.
3. Valve lists: Typed or printed plastic coated card(s), sized 216 mm (8-1/2 inches) by 280 mm (11 inches) showing tag number, valve function and area of control, for each service or system. Punch sheets for a 3-ring notebook.
4. Provide detailed plan for each floor of the building indicating the location and valve number for each valve. Identify location of each valve with a color coded thumb tack in ceiling.

2.9 FIRESTOPPING

Section 07 84 00, FIRESTOPPING specifies an effective barrier against the spread of fire, smoke and gases where penetrations occur for piping and ductwork. Refer to Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION, for firestop pipe and duct insulation.

2.10 GALVANIZED REPAIR COMPOUND

Mil. Spec. DOD-P-21035B, paint form.

2.11 HVAC PIPE AND EQUIPMENT SUPPORTS AND RESTRAINTS

A. Vibration Isolators: Refer to Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.

B. Supports for Roof Mounted Items:

1. Equipment: Equipment rails shall be galvanized steel, minimum 1.3 mm (18 gauge), with integral baseplate, continuous welded corner seams, factory installed 50 mm by 100 mm (2 by 4) treated wood nailer, 1.3 mm (18 gauge) galvanized steel counter flashing cap with screws, built-in cant strip, (except for gypsum or tectum deck), minimum height 280 mm (11 inches). For surface insulated roof deck, provide raised cant strip to start at the upper surface of the insulation.
2. Pipe/duct pedestals: Provide a galvanized Unistrut channel welded to U-shaped mounting brackets which are secured to side of rail with galvanized lag bolts.

- C. Pipe Supports: Comply with MSS SP-58. Type Numbers specified refer to this standard. For selection and application comply with MSS SP-69. Refer to Section 05 50 00, METAL FABRICATIONS, for miscellaneous metal support materials and prime coat painting requirements.
- D. Attachment to Concrete Building Construction:
1. Concrete insert: MSS SP-58, Type 18.
 2. Self-drilling expansion shields and machine bolt expansion anchors: Permitted in concrete not less than 102 mm (four inches) thick when approved by the Contracting Officer's Representative for each job condition.
 3. Power-driven fasteners: Permitted in existing concrete or masonry not less than 102 mm (four inches) thick when approved by the Contracting Officer's Representative for each job condition.
- E. Attachment to Steel Building Construction:
1. Welded attachment: MSS SP-58, Type 22.
 2. Beam clamps: MSS SP-58, Types 20, 21, 28 or 29. Type 23 C-clamp may be used for individual copper tubing up to 23mm (7/8-inch) outside diameter.
- F. Attachment to existing structure: Support from existing floor/roof frame.
- G. Hanger Rods: Hot-rolled steel, ASTM A36 or A575 for allowable load listed in MSS SP-58. For piping, provide adjustment means for controlling level or slope. Types 13 or 15 turn-buckles shall provide 38 mm (1-1/2 inches) minimum of adjustment and incorporate locknuts. All-thread rods are acceptable.
- H. Hangers Supporting Multiple Pipes (Trapeze Hangers): Galvanized, cold formed, lipped steel channel horizontal member, not less than 41 mm by 41 mm (1-5/8 inches by 1-5/8 inches), 2.7 mm (No. 12 gage), designed to accept special spring held, hardened steel nuts. Not permitted for steam supply and condensate piping.
1. Allowable hanger load: Manufacturers rating less 91kg (200 pounds).
 2. Guide individual pipes on the horizontal member of every other trapeze hanger with 6 mm (1/4-inch) U-bolt fabricated from steel rod. Provide Type 40 insulation shield, secured by two 13mm (1/2-inch) galvanized steel bands, or preinsulated calcium silicate shield for insulated piping at each hanger.
- I. Supports for Piping Systems:
1. Select hangers sized to encircle insulation on insulated piping. Refer to Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION for insulation thickness. To protect insulation, provide Type 39 saddles for roller type supports or preinsulated calcium

silicate shields. Provide Type 40 insulation shield or preinsulated calcium silicate shield at all other types of supports and hangers including those for preinsulated piping.

2. Piping Systems except High and Medium Pressure Steam (MSS SP-58):
 - a. Standard clevis hanger: Type 1; provide locknut.
 - b. Riser clamps: Type 8.
 - c. Wall brackets: Types 31, 32 or 33.
 - d. Roller supports: Type 41, 43, 44 and 46.
 - e. Saddle support: Type 36, 37 or 38.
 - f. Turnbuckle: Types 13 or 15. Preinsulate.
 - g. U-bolt clamp: Type 24.
 - h. Copper Tube:
 - 1) Hangers, clamps and other support material in contact with tubing shall be painted with copper colored epoxy paint, plastic coated or taped with non adhesive isolation tape to prevent electrolysis.
 - 2) For vertical runs use epoxy painted or plastic coated riser clamps.
 - 3) For supporting tube to strut: Provide epoxy painted pipe straps for copper tube or plastic inserted vibration isolation clamps.
 - 4) Insulated Lines: Provide pre-insulated calcium silicate shields sized for copper tube.
 - i. Supports for plastic or glass piping: As recommended by the pipe manufacturer with black rubber tape extending one inch beyond steel support or clamp.
3. High and Medium Pressure Steam (MSS SP-58):
 - a. Provide eye rod or Type 17 eye nut near the upper attachment.
 - b. Piping 50 mm (2 inches) and larger: Type 43 roller hanger. For roller hangers requiring seismic bracing provide a Type 1 clevis hanger with Type 41 roller attached by flat side bars.
 - c. Piping with Vertical Expansion and Contraction:
 - 1) Movement up to 20 mm (3/4-inch): Type 51 or 52 variable spring unit with integral turn buckle and load indicator.
 - 2) Movement more than 20 mm (3/4-inch): Type 54 or 55 constant support unit with integral adjusting nut, turn buckle and travel position indicator.

J. Pre-insulated Calcium Silicate Shields:

1. Provide 360 degree water resistant high density 965 kPa (140 psi) compressive strength calcium silicate shields encased in galvanized metal.

2. Pre-insulated calcium silicate shields to be installed at the point of support during erection.
 3. Shield thickness shall match the pipe insulation.
 4. The type of shield is selected by the temperature of the pipe, the load it must carry, and the type of support it will be used with.
 - a. Shields for supporting chilled or cold water shall have insulation that extends a minimum of 1 inch past the sheet metal. Provide for an adequate vapor barrier in chilled lines.
 - b. The pre-insulated calcium silicate shield shall support the maximum allowable water filled span as indicated in MSS-SP 69. To support the load, the shields may have one or more of the following features: structural inserts 4138 kPa (600 psi) compressive strength, an extra bottom metal shield, or formed structural steel (ASTM A36) wear plates welded to the bottom sheet metal jacket.
 5. Shields may be used on steel clevis hanger type supports, roller supports or flat surfaces.
- K. Hanger spacing: Maximum allowed spacings of pipe supports are indicated in the tables. Hanger rod sizes are minimum size allowed. Contractor's attention is directed to drawing details and building structural layout that may require hanger spacing more frequently than spacings shown in this table.

Screwed or welded steel pipe (liquid or vapor)

<u>Pipe Size</u>	<u>Maximum Hanger Spacing</u>	<u>Minimum Rod Size</u>
1/2 to 1 inch	8 feet	3/8 inch
1-1/4 through 2 inches	10 feet	3/8 inch
2-1/2 to 3-1/2 inches	12 feet	1/2 inch
4 and 5 inches	16 feet	5/8 inch

Copper tubing

<u>Pipe Size</u>	<u>Maximum Hanger Spacing</u>	<u>Minimum Rod Size</u>
1-1/4 inch and smaller	5 feet	3/8 inch
1-1/2 inches	7 feet	3/8 inch
2 inches	10 feet	3/8 inch
2-1/2 through 3-1/2 inches	10 feet	1/2 inch
4 inches	10 feet	5/8 inch

2.12 PIPE PENETRATIONS

- A. Install sleeves during construction for other than blocked out floor openings for risers in mechanical bays.
- B. To prevent accidental liquid spills from passing to a lower level, provide the following:
 - 1. For sleeves: Extend sleeve 25 mm (one inch) above finished floor and provide sealant for watertight joint.
 - 2. For blocked out floor openings: Provide 40 mm (1-1/2 inch) angle set in silicone adhesive around opening.
 - 3. For drilled penetrations: Provide 40 mm (1-1/2 inch) angle ring or square set in silicone adhesive around penetration.
- C. Penetrations are not allowed through beams or ribs, but may be installed in concrete beam flanges. Any deviation from these requirements must receive prior approval of Contracting Officer's Representative.
- D. Sheet Metal, Plastic, or Moisture-resistant Fiber Sleeves: Provide for pipe passing through floors, interior walls, and partitions, unless brass or steel pipe sleeves are specifically called for below.
- E. Brass Pipe Sleeves: Provide for pipe passing through quarry tile, terrazzo or ceramic tile floors. Connect sleeve with floor plate.
- F. Sleeves are not required for wall hydrants for fire department connections or in drywall construction.
- G. Sleeve Clearance: Sleeve through floors, walls, partitions, and beam flanges shall be one inch greater in diameter than external diameter of pipe. Sleeve for pipe with insulation shall be large enough to accommodate the insulation. Interior openings shall be caulked tight with fire stopping material and sealant to prevent the spread of fire, smoke, and gases.
- H. Sealant and Adhesives: Shall be as specified in Section 07 92 00, JOINT SEALANTS.

2.13 DUCT PENETRATIONS

- A. Provide curbs for roof mounted piping, ductwork and equipment. Curbs shall be 18 inches high with continuously welded seams, built-in cant strip, interior baffle with acoustic insulation, curb bottom, hinged curb adapter.
- B. Provide firestopping for openings through fire and smoke barriers, maintaining minimum required rating of floor, ceiling or wall assembly. See section 07 84 00, FIRESTOPPING.

2.14 SPECIAL TOOLS AND LUBRICANTS

- A. Furnish, and turn over to the Contracting Officer's Representative, tools not readily available commercially, that are required for disassembly or adjustment of equipment and machinery furnished.
- B. Grease Guns with Attachments for Applicable Fittings: One for each type of grease required for each motor or other equipment.
- C. Refrigerant Tools: Provide system charging/Evacuation equipment, gauges, fittings, and tools required for maintenance of furnished equipment.
- D. Tool Containers: Hardwood or metal, permanently identified for intended service and mounted, or located, where directed by the Contracting Officer's Representative.
- E. Lubricants: A minimum of 0.95 L (one quart) of oil, and 0.45 kg (one pound) of grease, of equipment manufacturer's recommended grade and type, in unopened containers and properly identified as to use for each different application.

2.15 WALL, FLOOR AND CEILING PLATES

- A. Material and Type: Chrome plated brass or chrome plated steel, one piece or split type with concealed hinge, with set screw for fastening to pipe, or sleeve. Use plates that fit tight around pipes, cover openings around pipes and cover the entire pipe sleeve projection.
- B. Thickness: Not less than 2.4 mm (3/32-inch) for floor plates. For wall and ceiling plates, not less than 0.64 mm (0.025-inch) for up to 80 mm (3-inch pipe), 0.89 mm (0.035-inch) for larger pipe.
- C. Locations: Use where pipe penetrates floors, walls and ceilings in exposed locations, in finished areas only. Provide a watertight joint in spaces where brass or steel pipe sleeves are specified.

2.16 ASBESTOS

Materials containing asbestos are not permitted.

PART 3 - EXECUTION

3.1 ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING

- A. Coordinate location of piping, sleeves, inserts, hangers, ductwork and equipment. Locate piping, sleeves, inserts, hangers, ductwork and equipment clear of windows, doors, openings, light outlets, and other services and utilities. Prepare equipment layout drawings to coordinate proper location and personnel access of all facilities. Submit the drawings for review as required by Part 1. Follow manufacturer's published recommendations for installation methods not otherwise specified.

- B. Operating Personnel Access and Observation Provisions: Select and arrange all equipment and systems to provide clear view and easy access, without use of portable ladders, for maintenance and operation of all devices including, but not limited to: all equipment items, valves, filters, strainers, transmitters, sensors, control devices. All gages and indicators shall be clearly visible by personnel standing on the floor or on permanent platforms. Do not reduce or change maintenance and operating space and access provisions that are shown on the drawings.
- C. Equipment and Piping Support: Coordinate structural systems necessary for pipe and equipment support with pipe and equipment locations to permit proper installation.
- D. Location of pipe sleeves, trenches and chases shall be accurately coordinated with equipment and piping locations.
- E. Cutting Holes:
1. Cut holes through concrete and masonry by rotary core drill. Pneumatic hammer, impact electric, and hand or manual hammer type drill will not be allowed, except as permitted by Contracting Officer's Representative where working area space is limited.
 2. Locate holes to avoid interference with structural members such as beams or grade beams. Holes shall be laid out in advance and drilling done only after approval by Contracting Officer's Representative. If the Contractor considers it necessary to drill through structural members, this matter shall be referred to Contracting Officer's Representative for approval.
 3. Do not penetrate membrane waterproofing.
- F. Interconnection of Instrumentation or Control Devices: Generally, electrical interconnections are not shown but must be provided.
- G. Minor Piping: Generally, small diameter pipe runs from drips and drains, water cooling, and other service are not shown but must be provided.
- H. Electrical Interconnection of Controls and Instruments: This generally not shown but must be provided. This includes interconnections of sensors, transmitters, transducers, control devices, control and instrumentation panels, instruments and computer workstations. Comply with NFPA-70.
- I. Protection and Cleaning:
1. Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the manufacturer's recommendations and as approved by the Contracting Officer's Representative. Damaged or defective items in the opinion of the Contracting Officer's Representative, shall be replaced.

2. Protect all finished parts of equipment, such as shafts and bearings where accessible, from rust prior to operation by means of protective grease coating and wrapping. Close pipe openings with caps or plugs during installation. Tightly cover and protect fixtures and equipment against dirt, water chemical, or mechanical injury. At completion of all work thoroughly clean fixtures, exposed materials and equipment.
- J. Concrete and Grout: Use concrete and shrink compensating grout 25 MPa (3000 psi) minimum, specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.
- K. Install gages, thermometers, valves and other devices with due regard for ease in reading or operating and maintaining said devices. Locate and position thermometers and gages to be easily read by operator or staff standing on floor or walkway provided. Servicing shall not require dismantling adjacent equipment or pipe work.
- L. Install steam piping expansion joints as per manufacturer's recommendations.
- M. Work in Existing Building:
1. Perform as specified in Article, OPERATIONS AND STORAGE AREAS, Article, ALTERATIONS, and Article, RESTORATION of the Section 01 00 00, GENERAL REQUIREMENTS for relocation of existing equipment, alterations and restoration of existing building(s).
 2. As specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, OPERATIONS AND STORAGE AREAS, make alterations to existing service piping at times that will least interfere with normal operation of the facility.
 3. Cut required openings through existing masonry and reinforced concrete using diamond core drills. Use of pneumatic hammer type drills, impact type electric drills, and hand or manual hammer type drills, will be permitted only with approval of the Contracting Officer's Representative. Locate openings that will least effect structural slabs, columns, ribs or beams. Refer to the Contracting Officer's Representative for determination of proper design for openings through structural sections and opening layouts approval, prior to cutting or drilling into structure. After Contracting Officer's Representative's approval, carefully cut opening through construction no larger than absolutely necessary for the required installation.
- N. Switchgear/Electrical Equipment Drip Protection: Every effort shall be made to eliminate the installation of pipe above electrical and telephone switchgear. If this is not possible, encase pipe in a second pipe with a minimum of joints. Installation of piping, ductwork, leak

protection apparatus or other installations foreign to the electrical installation shall be located in the space equal to the width and depth of the equipment and extending from to a height of 1.8 m (6 ft.) above the equipment of to ceiling structure, whichever is lower (NFPA 70).

O. Inaccessible Equipment:

1. Where the Government determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled or remedial action performed as directed at no additional cost to the Government.
2. The term "conveniently accessible" is defined as capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as motors, fans, pumps, belt guards, transformers, high voltage lines, piping, and ductwork.

3.2 TEMPORARY PIPING AND EQUIPMENT

- A. Continuity of operation of existing facilities will generally require temporary installation or relocation of equipment and piping.
- B. The Contractor shall provide all required facilities in accordance with the requirements of phased construction and maintenance of service. All piping and equipment shall be properly supported, sloped to drain, operate without excessive stress, and shall be insulated where injury can occur to personnel by contact with operating facilities. The requirements of Paragraph 3.1 apply.
- C. Temporary facilities and piping shall be completely removed and any openings in structures sealed. Provide necessary blind flanges and caps to seal open piping remaining in service.

3.3 RIGGING

- A. Design is based on application of available equipment. Openings in building structures shall be planned to accommodate design scheme.
- B. Alternative methods of equipment delivery may be offered by Contractor and will be considered by Government under specified restrictions of phasing and maintenance of service as well as structural integrity of the building.
- C. Close all openings in the building when not required for rigging operations to maintain proper environment in the facility for Government operation and maintenance of service.
- D. Contractor shall provide all facilities required to deliver specified equipment and place on foundations. Attachments to structures for rigging purposes and support of equipment on structures shall be Contractor's full responsibility. Upon request, the Government will check structure adequacy and advise Contractor of recommended restrictions.

- E. Contractor shall check all clearances, weight limitations and shall offer a rigging plan designed by a Registered Professional Engineer. All modifications to structures, including reinforcement thereof, shall be at Contractor's cost, time and responsibility.
- F. Rigging plan and methods shall be referred to Contracting Officer's Representative for evaluation prior to actual work.
- G. Restore building to original condition upon completion of rigging work.

3.4 PIPE AND EQUIPMENT SUPPORTS

- A. Where hanger spacing does not correspond with joist or rib spacing, use structural steel channels secured directly to joist and rib structure that will correspond to the required hanger spacing, and then suspend the equipment and piping from the channels. Drill or burn holes in structural steel only with the prior approval of the Contracting Officer's Representative.
- B. Use of chain, wire or strap hangers; wood for blocking, stays and bracing; or, hangers suspended from piping above will not be permitted. Replace or thoroughly clean rusty products and paint with zinc primer.
- C. Use hanger rods that are straight and vertical. Turnbuckles for vertical adjustments may be omitted where limited space prevents use. Provide a minimum of 15 mm (1/2-inch) clearance between pipe or piping covering and adjacent work.
- D. HVAC Horizontal Pipe Support Spacing: Refer to MSS SP-69. Provide additional supports at valves, strainers, in-line pumps and other heavy components. Provide a support within one foot of each elbow.
- E. HVAC Vertical Pipe Supports:
 - 1. Up to 150 mm (6-inch pipe), 9 m (30 feet) long, bolt riser clamps to the pipe below couplings, or welded to the pipe and rests supports securely on the building structure.
 - 2. Vertical pipe larger than the foregoing, support on base elbows or tees, or substantial pipe legs extending to the building structure.
- F. Overhead Supports:
 - 1. The basic structural system of the building is designed to sustain the loads imposed by equipment and piping to be supported overhead.
 - 2. Provide steel structural members, in addition to those shown, of adequate capability to support the imposed loads, located in accordance with the final approved layout of equipment and piping.
 - 3. Tubing and capillary systems shall be supported in channel troughs.

G. Floor Supports:

1. Provide concrete bases, concrete anchor blocks and pedestals, and structural steel systems for support of equipment and piping. Anchor and dowel concrete bases and structural systems to resist forces under operating and seismic conditions (if applicable) without excessive displacement or structural failure.
2. Do not locate or install bases and supports until equipment mounted thereon has been approved. Size bases to match equipment mounted thereon plus 50 mm (2 inch) excess on all edges. Boiler foundations shall have horizontal dimensions that exceed boiler base frame dimensions by at least 150 mm (6 inches) on all sides. Refer to structural drawings. Bases shall be neatly finished and smoothed, shall have chamfered edges at the top, and shall be suitable for painting.
3. All equipment shall be shimmed, leveled, firmly anchored, and grouted with epoxy grout. Anchor bolts shall be placed in sleeves, anchored to the bases. Fill the annular space between sleeves and bolts with a granular material to permit alignment and realignment.

3.5 MECHANICAL DEMOLITION

- A. Rigging access, other than indicated on the drawings, shall be provided by the Contractor after approval for structural integrity by the Contracting Officer's Representative. Such access shall be provided without additional cost or time to the Government. Where work is in an operating plant, provide approved protection from dust and debris at all times for the safety of plant personnel and maintenance of plant operation and environment of the plant.
- B. In an operating facility, maintain the operation, cleanliness and safety. Government personnel will be carrying on their normal duties of operating, cleaning and maintaining equipment and plant operation. Confine the work to the immediate area concerned; maintain cleanliness and wet down demolished materials to eliminate dust. Do not permit debris to accumulate in the area to the detriment of plant operation. Perform all flame cutting to maintain the fire safety integrity of this plant. Adequate fire extinguishing facilities shall be available at all times. Perform all work in accordance with recognized fire protection standards. Inspection will be made by personnel of the VAMC, and Contractor shall follow all directives of the Contracting Officer's Representative with regard to rigging, safety, fire safety, and maintenance of operations.

- C. Completely remove all piping, wiring, conduit, and other devices associated with the equipment not to be re-used in the new work. This includes all pipe, valves, fittings, insulation, and all hangers including the top connection and any fastenings to building structural systems. Seal all openings, after removal of equipment, pipes, ducts, and other penetrations in roof, walls, floors, in an approved manner and in accordance with plans and specifications where specifically covered. Structural integrity of the building system shall be maintained. Reference shall also be made to the drawings and specifications of the other disciplines in the project for additional facilities to be demolished or handled.
- D. All valves including gate, globe, ball, butterfly and check, all pressure gages and thermometers with wells shall remain Government property and shall be removed and delivered to Contracting Officer's Representative and stored as directed. The Contractor shall remove all other material and equipment, devices and demolition debris under these plans and specifications. Such material shall be removed from Government property expeditiously and shall not be allowed to accumulate.

3.6 CLEANING AND PAINTING

- A. Prior to final inspection and acceptance of the plant and facilities for beneficial use by the Government, the plant facilities, equipment and systems shall be thoroughly cleaned and painted. Refer to Section 09 91 00, PAINTING.
- B. In addition, the following special conditions apply:
 - 1. Cleaning shall be thorough. Use solvents, cleaning materials and methods recommended by the manufacturers for the specific tasks. Remove all rust prior to painting and from surfaces to remain unpainted. Repair scratches, scuffs, and abrasions prior to applying prime and finish coats.
 - 2. Material And Equipment Not To Be Painted Includes:
 - a. Motors, controllers, control switches, and safety switches.
 - b. Control and interlock devices.
 - c. Regulators.
 - d. Pressure reducing valves.
 - e. Control valves and thermostatic elements.
 - f. Lubrication devices and grease fittings.
 - g. Copper, brass, aluminum, stainless steel and bronze surfaces.
 - h. Valve stems and rotating shafts.
 - i. Pressure gauges and thermometers.
 - j. Glass.
 - k. Name plates.

3. Control and instrument panels shall be cleaned, damaged surfaces repaired, and shall be touched-up with matching paint obtained from panel manufacturer.
4. Pumps, motors, steel and cast iron bases, and coupling guards shall be cleaned, and shall be touched-up with the same color as utilized by the pump manufacturer
5. Temporary Facilities: Apply paint to surfaces that do not have existing finish coats.
6. Paint shall withstand the following temperatures without peeling or discoloration:
 - a. Condensate and feedwater -- 38 degrees C (100 degrees F) on insulation jacket surface and 120 degrees C (250 degrees F) on metal pipe surface.
 - b. Steam -- 52 degrees C (125 degrees F) on insulation jacket surface and 190 degrees C (375 degrees F) on metal pipe surface.
7. Final result shall be smooth, even-colored, even-textured factory finish on all items. Completely repaint the entire piece of equipment if necessary to achieve this.

3.7 IDENTIFICATION SIGNS

- A. Provide laminated plastic signs, with engraved lettering not less than 5 mm (3/16-inch) high, designating functions, for all equipment, switches, motor controllers, relays, meters, control devices, including automatic control valves. Nomenclature and identification symbols shall correspond to that used in maintenance manual, and in diagrams specified elsewhere. Attach by chain, adhesive, or screws.
- B. Factory Built Equipment: Metal plate, securely attached, with name and address of manufacturer, serial number, model number, size, performance.
- C. Pipe Identification: Refer to Section 09 91 00, PAINTING.

3.8 MOTOR AND DRIVE ALIGNMENT

- A. Belt Drive: Set driving and driven shafts parallel and align so that the corresponding grooves are in the same plane.
- B. Direct-connect Drive: Securely mount motor in accurate alignment so that shafts are free from both angular and parallel misalignment when both motor and driven machine are operating at normal temperatures.

3.9 LUBRICATION

- A. Lubricate all devices requiring lubrication prior to initial operation. Field-check all devices for proper lubrication.
- B. Equip all devices with required lubrication fittings or devices. Provide a minimum of one liter (one quart) of oil and 0.5 kg (one pound) of grease of manufacturer's recommended grade and type for each different application; also provide 12 grease sticks for lubricated plug valves.

Deliver all materials to Contracting Officer's Representative in unopened containers that are properly identified as to application.

- C. Provide a separate grease gun with attachments for applicable fittings for each type of grease applied.
- D. All lubrication points shall be accessible without disassembling equipment, except to remove access plates.

3.10 COMMISSIONING

- A. Commissioning will be performed by the system manufacturer. Provide commissioning documentation in accordance with the requirements of Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS for all inspection, start up, and testing required above.
- B. Components provided under this section of the specifications will be tested as part of a larger system.

3.11 STARTUP AND TEMPORARY OPERATION

Start up equipment as described in equipment specifications. Verify that vibration is within specified tolerance prior to extended operation. Temporary use of equipment is specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, TEMPORARY USE OF MECHANICAL AND ELECTRICAL EQUIPMENT.

3.12 OPERATING AND PERFORMANCE TESTS

- A. Prior to the final inspection, perform required tests as specified in Section 01 00 00, GENERAL REQUIREMENTS and submit the test reports and records to the Contracting Officer's Representative.
- B. Should evidence of malfunction in any tested system, or piece of equipment or component part thereof, occur during or as a result of tests, make proper corrections, repairs or replacements, and repeat tests at no additional cost to the Government.
- C. When completion of certain work or system occurs at a time when final control settings and adjustments cannot be properly made to make performance tests, then make performance tests for heating systems and for cooling systems respectively during first actual seasonal use of respective systems following completion of work.

3.13 INSTRUCTIONS TO VAMC PERSONNEL

Provide in accordance with Article, INSTRUCTIONS, of Section 01 00 00, GENERAL REQUIREMENTS, and Section 23 08 11, DEMONSTRATIONS AND TESTS FOR BOILER PLANT.

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SECTION 23 05 12
GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION:

This section specifies the furnishing, installation and connection of motors for HVAC and steam generation equipment.

1.2 RELATED WORK:

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements common to more than one Section of Division 26.
- B. Section 26 24 19, MOTOR-CONTROL CENTERS: Multiple motor control assemblies, which include motor starters.
- C. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- D. Section 23 34 00, HVAC FANS.
- E. Section 23 73 00, INDOOR CENTRAL-STATION AIR-HANDLING UNITS.
- F. Section 23 74 13, PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS.
- G. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS: Requirements for commissioning, systems readiness checklists, and training.

1.3 SUBMITTALS:

- A. In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:
- B. Shop Drawings:
 - 1. Provide documentation to demonstrate compliance with drawings and specifications.
 - 2. Include electrical ratings, efficiency, bearing data, power factor, frame size, dimensions, mounting details, materials, horsepower, voltage, phase, speed (RPM), enclosure, starting characteristics, torque characteristics, code letter, full load and locked rotor current, service factor, and lubrication method.
- C. Manuals:
 - 1. Submit simultaneously with the shop drawings, companion copies of complete installation, maintenance and operating manuals, including technical data sheets and application data.
- D. Certification: Two weeks prior to final inspection, unless otherwise noted, submit four copies of the following certification to the Contracting Officer Technical Representative:
 - 1. Certification that the motors have been applied, installed, adjusted, lubricated, and tested according to manufacturer published recommendations.

- E. Completed System Readiness Checklists provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 23 08 00 COMMISSIONING OF HVAC SYSTEMS.

1.4 APPLICABLE PUBLICATIONS:

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. National Electrical Manufacturers Association (NEMA):
 MG 1-2006 Rev. 1 2009 ..Motors and Generators
 MG 2-2001 Rev. 1 2007...Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators
- C. National Fire Protection Association (NFPA):
 70-2008.....National Electrical Code (NEC)
- D. Institute of Electrical and Electronics Engineers (IEEE):
 112-04.....Standard Test Procedure for Polyphase Induction Motors and Generators
- E. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
 90.1-2007.....Energy Standard for Buildings Except Low-Rise Residential Buildings

PART 2 - PRODUCTS

2.1 MOTORS:

- A. For alternating current, fractional and integral horsepower motors, NEMA Publications MG 1 and MG 2 shall apply including Part 31 of NEMA MG 1.
- B. All material and equipment furnished and installation methods shall conform to the requirements of Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS; and Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW). Provide all electrical wiring, conduit, and devices necessary for the proper connection, protection and operation of the systems. Provide premium efficiency type motors as scheduled. Unless otherwise specified for a particular application, use electric motors with the following requirements.
- C. Single-phase Motors: Motors for centrifugal fans and pumps may be split phase or permanent split capacitor (PSC) type. Provide capacitor-start type for hard starting applications.
- D. Voltage ratings shall be as follows:
 - 1. Single phase:
 - a. Motors connected to 120-volt systems: 115 volts.

2. Three phase:
 - b. Motors, less than 74.6 kW (100 HP), connected to 240 volt or 480 volt systems: 208-230/460 volts, dual connection.
- E. Number of phases shall be as follows:
 1. Motors, less than 373 W (1/2 HP): Single phase.
 2. Motors, 373 W (1/2 HP) and larger: 3 phase.
 3. Exceptions:
 - a. Hermetically sealed motors.
 - b. Motors for equipment assemblies, less than 746 W (one HP), may be single phase provided the manufacturer of the proposed assemblies cannot supply the assemblies with three phase motors.
- F. Motors shall be designed for operating the connected loads continuously in a 40°C (104°F) environment, where the motors are installed, without exceeding the NEMA standard temperature rises for the motor insulation. If the motors exceed 40°C (104°F), the motors shall be rated for the actual ambient temperatures.
- G. Motor designs, as indicated by the NEMA code letters, shall be coordinated with the connected loads to assure adequate starting and running torque.
- H. Motor Enclosures:
 1. Shall be the NEMA types as specified and/or shown on the drawings.
 2. Where the types of motor enclosures are not shown on the drawings, they shall be the NEMA types, which are most suitable for the environmental conditions where the motors are being installed. Enclosure requirements for certain conditions are as follows:
 - a. Motors located outdoors, indoors in wet or high humidity locations, or in unfiltered airstreams shall be totally enclosed type.
 - b. Where motors are located in an NEC 511 classified area, provide TEFC explosion proof motor enclosures.
 - c. Where motors are located in a corrosive environment, provide TEFC enclosures with corrosion resistant finish.
 3. Enclosures shall be primed and finish coated at the factory with manufacturer's prime coat and standard finish.
- I. Special Requirements:
 1. Where motor power requirements of equipment furnished deviate from power shown on plans, provide electrical service designed under the requirements of NFPA 70 without additional time or cost to the Government.

2. Assemblies of motors, starters, controls and interlocks on factory assembled and wired devices shall be in accordance with the requirements of this specification.
3. Wire and cable materials specified in the electrical division of the specifications shall be modified as follows:
 - a. Wiring material located where temperatures can exceed 71 degrees C (160 degrees F) shall be stranded copper with Teflon FEP insulation with jacket. This includes wiring on the boilers.
 - b. Other wiring at boilers and to control panels shall be NFPA 70 designation THWN.
 - c. Provide shielded conductors or wiring in separate conduits for all instrumentation and control systems where recommended by manufacturer of equipment.
4. Select motor sizes so that the motors do not operate into the service factor at maximum required loads on the driven equipment. Motors on pumps shall be sized for non-overloading at all points on the pump performance curves.
5. Motors utilized with variable frequency drives shall be rated "inverter-duty" per NEMA Standard, MG1, Part 31.4.4.2. Provide motor shaft grounding apparatus that will protect bearings from damage from stray currents.
- J. Additional requirements for specific motors, as indicated in the other sections listed in Article 1.2, shall also apply.
- K. Energy-Efficient Motors (Motor Efficiencies): All permanently wired polyphase motors of 746 Watts (1 HP) or more shall meet the minimum full-load efficiencies as indicated in the following table. Motors of 746 Watts or more with open, drip-proof or totally enclosed fan-cooled enclosures shall be NEMA premium efficiency type, unless otherwise indicated. Motors provided as an integral part of motor driven equipment are excluded from this requirement if a minimum seasonal or overall efficiency requirement is indicated for that equipment by the provisions of another section. Motors not specified as "premium efficiency" shall comply with the Energy Policy Act of 2005 (EPACT).

Minimum Premium Efficiencies Open Drip-Proof				Minimum Premium Efficiencies Totally Enclosed Fan-Cooled			
Rating kW (HP)	1200 RPM	1800 RPM	3600 RPM	Rating kW (HP)	1200 RPM	1800 RPM	3600 RPM
0.746 (1)	82.5%	85.5%	77.0%	0.746 (1)	82.5%	85.5%	77.0%
1.12 (1.5)	86.5%	86.5%	84.0%	1.12 (1.5)	87.5%	86.5%	84.0%
1.49 (2)	87.5%	86.5%	85.5%	1.49 (2)	88.5%	86.5%	85.5%
2.24 (3)	88.5%	89.5%	85.5%	2.24 (3)	89.5%	89.5%	86.5%
3.73 (5)	89.5%	89.5%	86.5%	3.73 (5)	89.5%	89.5%	88.5%
5.60 (7.5)	90.2%	91.0%	88.5%	5.60 (7.5)	91.0%	91.7%	89.5%
7.46 (10)	91.7%	91.7%	89.5%	7.46 (10)	91.0%	91.7%	90.2%
11.2 (15)	91.7%	93.0%	90.2%	11.2 (15)	91.7%	92.4%	91.0%
14.9 (20)	92.4%	93.0%	91.0%	14.9 (20)	91.7%	93.0%	91.0%
18.7 (25)	93.0%	93.6%	91.7%	18.7 (25)	93.0%	93.6%	91.7%
22.4 (30)	93.6%	94.1%	91.7%	22.4 (30)	93.0%	93.6%	91.7%
29.8 (40)	94.1%	94.1%	92.4%	29.8 (40)	94.1%	94.1%	92.4%
37.3 (50)	94.1%	94.5%	93.0%	37.3 (50)	94.1%	94.5%	93.0%
44.8 (60)	94.5%	95.0%	93.6%	44.8 (60)	94.5%	95.0%	93.6%
56.9 (75)	94.5%	95.0%	93.6%	56.9 (75)	94.5%	95.4%	93.6%
74.6 (100)	95.0%	95.4%	93.6%	74.6 (100)	95.0%	95.4%	94.1%
93.3 (125)	95.0%	95.4%	94.1%	93.3 (125)	95.0%	95.4%	95.0%
112 (150)	95.4%	95.8%	94.1%	112 (150)	95.8%	95.8%	95.0%
149.2 (200)	95.4%	95.8%	95.0%	149.2 (200)	95.8%	96.2%	95.4%

L. Minimum Power Factor at Full Load and Rated Voltage: 90 percent at 1200 RPM, 1800 RPM and 3600 RPM.

PART 3 - EXECUTION

3.1 INSTALLATION:

Install motors in accordance with manufacturer's recommendations, the NEC, NEMA, as shown on the drawings and/or as required by other sections of these specifications.

3.2 FIELD TESTS

- A. Perform an electric insulation resistance Test using a megohmmeter on all motors after installation, before start-up. All shall test free from grounds.
- B. Perform Load test in accordance with ANSI/IEEE 112, Test Method B, to determine freedom from electrical or mechanical defects and compliance with performance data.

- C. Insulation Resistance: Not less than one-half meg-ohm between stator conductors and frame, to be determined at the time of final inspection.

3.3 STARTUP AND TESTING

- A. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with Contracting Officer Technical Representative and Commissioning Agent. Provide a minimum of 7 days prior notice.

3.4 COMMISSIONING

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

3.5 DEMONSTRATION AND TRAINING

- A. Provide services of manufacturer's technical representative for four hours to instruct VAMC personnel in operation and maintenance of units.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS.

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SECTION 23 05 41
NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

Noise criteria, vibration tolerance and vibration isolation for HVAC and plumbing work.

1.2 RELATED WORK

- A. Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION: General mechanical requirements and items, which are common to more than one section of Division 23.
- B. Section 23 22 13, STEAM and CONDENSATE HEATING PIPING: Requirements for flexible pipe connectors to reciprocating and rotating mechanical equipment.
- C. Section 23 73 00, INDOOR CENTRAL-STATION AIR-HANDLING UNITS: Requirements for optional Air Handling Unit internal vibration isolation.
- D. Section 23 31 00, HVAC DUCTS and CASINGS: requirements for flexible duct connectors, sound attenuators and sound absorbing duct lining.
- E. SECTION 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC: requirements for sound and vibration tests.
- F. SECTION 23 37 00, AIR OUTLETS and INLETS: noise requirements for G-grilles.
- G. SECTION 23 34 00, HVAC FANS: sound and vibration isolation requirements for fans.
- H. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS: Requirements for commissioning, systems readiness checklists, and training.

1.3 QUALITY ASSURANCE

- A. Refer to article, QUALITY ASSURANCE in specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- B. Noise Criteria:
 - 1. Noise levels in all 8 octave bands due to equipment and duct systems shall not exceed following NC levels:

TYPE OF ROOM	NC LEVEL
Bathrooms and Toilet Rooms	40
Corridors(Public)	40
Dining Rooms, Food Services/ Serving	40
Kitchens	50
Offices, Small Private	35
Shops	50

2. For equipment which has no sound power ratings scheduled on the plans, the contractor shall select equipment such that the foregoing noise criteria, local ordinance noise levels, and OSHA requirements are not exceeded. Selection procedure shall be in accordance with ASHRAE Fundamentals Handbook, Chapter 7, Sound and Vibration.
 3. An allowance, not to exceed 5db, may be added to the measured value to compensate for the variation of the room attenuating effect between room test condition prior to occupancy and design condition after occupancy which may include the addition of sound absorbing material, such as, furniture. This allowance may not be taken after occupancy. The room attenuating effect is defined as the difference between sound power level emitted to room and sound pressure level in room.
 4. In absence of specified measurement requirements, measure equipment noise levels three feet from equipment and at an elevation of maximum noise generation.
- C. Allowable Vibration Tolerances for Rotating, Non-reciprocating Equipment: Not to exceed a self-excited vibration maximum velocity of 5 mm per second (0.20 inch per second) RMS, filter in, when measured with a vibration meter on bearing caps of machine in vertical, horizontal and axial directions or measured at equipment mounting feet if bearings are concealed. Measurements for internally isolated fans and motors may be made at the mounting feet.

1.4 SUBMITTALS

- A. Submit in accordance with specification Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.

B. Manufacturer's Literature and Data:

1. Vibration isolators:

- a. Floor mountings
- b. Hangers
- c. Snubbers

2. Bases.

- C. Isolator manufacturer shall furnish with submittal load calculations for selection of isolators, including supplemental bases, based on lowest operating speed of equipment supported.

1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE):
- 2009Fundamentals Handbook, Chapter 7, Sound and Vibration
- C. American Society for Testing and Materials (ASTM):
- A123/A123M-09.....Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- A307-07b.....Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
- D2240-05(2010).....Standard Test Method for Rubber Property - Durometer Hardness
- D. Manufacturers Standardization (MSS):
- SP-58-2009.....Pipe Hangers and Supports-Materials, Design and Manufacture
- E. Occupational Safety and Health Administration (OSHA):
- 29 CFR 1910.95.....Occupational Noise Exposure
- F. American Society of Civil Engineers (ASCE):
- ASCE 7-10Minimum Design Loads for Buildings and Other Structures.
- G. American National Standards Institute / Sheet Metal and Air Conditioning Contractor's National Association (ANSI/SMACNA):
- 001-2008.....Seismic Restraint Manual: Guidelines for Mechanical Systems, 3rd Edition.

- H. International Code Council (ICC):
2009 IBC.....International Building Code.
- I. Department of Veterans Affairs (VA):
H-18-8 2010.....Seismic Design Requirements.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Type of isolator, base, and minimum static deflection shall be as required for each specific equipment application as recommended by isolator or equipment manufacturer but subject to minimum requirements indicated herein and in the schedule on the drawings.
- B. Elastometric Isolators shall comply with ASTM D2240 and be oil resistant neoprene with a maximum stiffness of 60 durometer and have a straight-line deflection curve.
- C. Uniform Loading: Select and locate isolators to produce uniform loading and deflection even when equipment weight is not evenly distributed.
- D. Color code isolators by type and size for easy identification of capacity.

2.2 VIBRATION ISOLATORS

- A. Floor Mountings:
 - 1. Double Deflection Neoprene (Type N): Shall include neoprene covered steel support plated (top and bottom), friction pads, and necessary bolt holes.
 - 2. Spring Isolators (Type S): Shall be free-standing, laterally stable and include acoustical friction pads and leveling bolts. Isolators shall have a minimum ratio of spring diameter-to-operating spring height of 1.0 and an additional travel to solid equal to 50 percent of rated deflection.
 - 3. Pads (Type D), Washers (Type W), and Bushings (Type L): Pads shall be natural rubber or neoprene waffle, neoprene and steel waffle, or reinforced duck and neoprene. Washers and bushings shall be reinforced duck and neoprene. Washers and bushings shall be reinforced duck and neoprene. Size pads for a maximum load of 345 kPa (50 pounds per square inch).

- B. Hangers: Shall be combination neoprene and springs unless otherwise noted and shall allow for expansion of pipe.
1. Combination Neoprene and Spring (Type H): Vibration hanger shall contain a spring and double deflection neoprene element in series. Spring shall have a diameter not less than 0.8 of compressed operating spring height. Spring shall have a minimum additional travel of 50 percent between design height and solid height. Spring shall permit a 15 degree angular misalignment without rubbing on hanger box.
 2. Neoprene (Type HN): Vibration hanger shall contain a double deflection type neoprene isolation element. Hanger rod shall be separated from contact with hanger bracket by a neoprene grommet.
 3. Spring (Type HS): Vibration hanger shall contain a coiled steel spring in series with a neoprene grommet. Spring shall have a diameter not less than 0.8 of compressed operating spring height. Spring shall have a minimum additional travel of 50 percent between design height and solid height. Spring shall permit a 15 degree angular misalignment without rubbing on hanger box.
 4. Hanger supports for piping 50 mm (2 inches) and larger shall have a pointer and scale deflection indicator.
- C. Snubbers: Each spring mounted base shall have a minimum of four all-directional or eight two directional (two per side) seismic snubbers that are double acting. Elastomeric materials shall be shock absorbent neoprene bridge quality bearing pads, maximum 60 durometer, replaceable and have a minimum thickness of 6 mm (1/4 inch). Air gap between hard and resilient material shall be not less than 3 mm (1/8 inch) nor more than 6 mm (1/4 inch). Restraints shall be capable of withstanding design load without permanent deformation.
- D. Thrust Restraints (Type THR): Restraints shall provide a spring element contained in a steel frame with neoprene pads at each end attachment. Restraints shall have factory preset thrust and be field adjustable to allow a maximum movement of 6 mm (1/4 inch) when the fan starts and stops. Restraint assemblies shall include rods, angle brackets and other hardware for field installation.

2.3 BASES

- A. Rails (Type R): Design rails with isolator brackets to reduce mounting height of equipment and cradle machines having legs or bases that do not require a complete supplementary base. To assure adequate

stiffness, height of members shall be a minimum of 1/12 of longest base dimension but not less than 100 mm (4 inches). Where rails are used with neoprene mounts for small fans or close coupled pumps, extend rails to compensate overhang of housing.

- B. Integral Structural Steel Base (Type B): Design base with isolator brackets to reduce mounting height of equipment which require a complete supplementary rigid base. To assure adequate stiffness, height of members shall be a minimum of 1/12 of longest base dimension, but not less than 100 mm (four inches).

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Vibration Isolation:
 1. No metal-to-metal contact will be permitted between fixed and floating parts.
 2. Connections to Equipment: Allow for deflections equal to or greater than equipment deflections. Electrical, drain, piping connections, and other items made to rotating or reciprocating equipment (pumps, compressors, etc.) which rests on vibration isolators, shall be isolated from building structure for first three hangers or supports with a deflection equal to that used on the corresponding equipment.
 3. Common Foundation: Mount each electric motor on same foundation as driven machine. Hold driving motor and driven machine in positive rigid alignment with provision for adjusting motor alignment and belt tension. Bases shall be level throughout length and width. Provide shims to facilitate pipe connections, leveling, and bolting.
 4. Provide heat shields where elastomers are subject to temperatures over 38 degrees C (100 degrees F).
- B. Inspection and Adjustments: Check for vibration and noise transmission through connections, piping, ductwork, foundations, and walls. Adjust, repair, or replace isolators as required to reduce vibration and noise transmissions to specified levels.

3.2 ADJUSTING

- A. Adjust vibration isolators after piping systems are filled and equipment is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

- C. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4inch (6-mm) movement during start and stop.
- D. Adjust active height of spring isolators.
- E. Adjust snubbers according to manufacturer's recommendations.

3.3 COMMISSIONING

- A. Provide commissioning documentation in accordance with the requirements of section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

- - - E N D - - -

SELECTION GUIDE FOR VIBRATION ISOLATORS

EQUIPMENT	ON GRADE			20FT FLOOR SPAN			30FT FLOOR SPAN			40FT FLOOR SPAN			50FT FLOOR SPAN		
	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL
CENTRIFUGAL FANS															
UP TO 50 HP:															
UP TO 200 RPM	B	N	0.3	B	S	2.5	B	S	2.5	B	S	3.5	B	S	3.5
201 - 300 RPM	B	N	0.3	B	S	2.0	B	S	2.5	B	S	2.5	B	S	3.5
301 - 500 RPM	B	N	0.3	B	S	2.0	B	S	2.0	B	S	2.5	B	S	3.5
501 RPM & OVER	B	N	0.3	B	S	2.0	B	S	2.0	B	S	2.0	B	S	2.5
AIR HANDLING UNIT PACKAGES															
FLOOR MOUNTED:															
UP THRU 5 HP	---	D	---	---	S	1.0	---	S	1.0	---	S	1.0	---	S	1.0
7-1/2 HP & OVER:															
UP TO 500 RPM	---	D	---	R	S, THR	1.5	R	S, THR	2.5	R	S, THR	2.5	R	S, THR	2.5
501 RPM & OVER	---	D	---	---	S, THR	0.8	---	S, THR	0.8	R	S, THR	1.5	R	S, THR	2.0
CONDENSING UNITS															
ALL	---	SS	0.25	---	SS	0.75	---	SS	1.5	CB	SS	1.5	---	---	NA

SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Testing, adjusting, and balancing (TAB) of heating, ventilating and air conditioning (HVAC) systems. TAB includes the following:
 - 1. Planning systematic TAB procedures.
 - 2. Design Review Report.
 - 3. Systems Inspection report.
 - 4. Duct Air Leakage test report.
 - 5. Systems Readiness Report.
 - 6. Balancing air and water distribution systems; adjustment of total system to provide design performance; and testing performance of equipment and automatic controls.
 - 7. Vibration and sound measurements.
 - 8. Recording and reporting results.
- B. Definitions:
 - 1. Basic TAB used in this Section: Chapter 37, "Testing, Adjusting and Balancing" of ASHRAE Handbook, "HVAC Applications".
 - 2. TAB: Testing, Adjusting and Balancing; the process of checking and adjusting HVAC systems to meet design objectives.
 - 3. AABC: Associated Air Balance Council.
 - 4. NEBB: National Environmental Balancing Bureau.
 - 5. Hydronic Systems: Includes chilled water and heating hot water.
 - 6. Air Systems: Includes all outside air, supply air, return air, exhaust air and relief air systems.
 - 7. Flow rate tolerance: The allowable percentage variation, minus to plus, of actual flow rate from values (design) in the contract documents.

1.2 RELATED WORK

- A. Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION: General Mechanical Requirements.
- B. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT: Noise and Vibration Requirements.
- C. Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION: Piping and Equipment Insulation.

- D. Section 23 36 00, AIR TERMINAL UNITS: Terminal Units Performance.
- E. Section 23 31 00, HVAC DUCTS AND CASINGS: Duct Leakage.
- F. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC: Controls and Instrumentation Settings.

1.3 QUALITY ASSURANCE

- A. Refer to Articles, Quality Assurance and Submittals, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.
- B. Qualifications:
 1. TAB Agency: The TAB agency shall be a subcontractor of the General Contractor and shall report to and be paid by the General Contractor.
 2. The TAB agency shall be either a certified member of AABC or certified by the NEBB to perform TAB service for HVAC, water balancing and vibrations and sound testing of equipment. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the agency loses subject certification during this period, the General Contractor shall immediately notify the Contracting Officer Technical Representative and submit another TAB firm for approval. Any agency that has been the subject of disciplinary action by either the AABC or the NEBB within the (3) years preceding Contract Award shall not be eligible to perform any work related to the TAB. All work performed in this Section and in other related Sections by the TAB agency shall be considered invalid if the TAB agency loses its certification prior to Contract completion, and the successor agency's review shows unsatisfactory work performed by the predecessor agency.
 3. TAB Specialist: The TAB specialist shall be either a member of AABC or an experienced technician of the Agency certified by NEBB. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the Specialist loses subject certification during this period, the General Contractor shall immediately notify the Contracting Officer Technical Representative and submit another TAB Specialist for approval. Any individual that has been the subject of disciplinary action by either the AABC or the NEBB within the (3) years preceding Contract Award shall not be eligible to perform any duties related to the HVAC systems,

- including TAB. All work specified in this Section and in other related Sections performed by the TAB specialist shall be considered invalid if the TAB Specialist loses its certification prior to Contract completion and must be performed by an approved successor.
4. TAB Specialist shall be identified by the General Contractor within 60 calendar days after receipt of the Notice to Proceed. The TAB specialist will be coordinating, scheduling and reporting all TAB work and related activities and will provide necessary information as required by the Contracting Officer Technical Representative. The responsibilities would specifically include:
 - a. Shall directly supervise all TAB work.
 - b. Shall sign the TAB reports that bear the seal of the TAB standard. The reports shall be accompanied by report forms and schematic drawings required by the TAB standard, AABC or NEBB.
 - c. Would follow all TAB work through its satisfactory completion.
 - d. Shall provide final markings of settings of all HVAC adjustment devices.
 - e. Permanently mark location of duct test ports.
 5. All TAB technicians performing actual TAB work shall be experienced and must have done satisfactory work on a minimum of 3 projects comparable in size and complexity to this project. Qualifications must be certified by the TAB agency in writing.
- C. Test Equipment Criteria: The instrumentation shall meet the accuracy/calibration requirements established by AABC National Standards or by NEBB Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems and instrument manufacturer. Provide calibration history of the instruments to be used for test and balance purpose.
- D. TAB Criteria:
1. One or more of the applicable AABC, NEBB or SMACNA publications, supplemented by ASHRAE Handbook "HVAC Applications" Chapter 36, and requirements stated herein shall be the basis for planning, procedures, and reports.
 2. Flow rate tolerance: Following tolerances are allowed. For tolerances not mentioned herein follow ASHRAE Handbook "HVAC Applications", Chapter 36, as a guideline. Air Filter resistance during tests, artificially imposed if necessary, shall be at least 90 percent of final values for pre-filters and after-filters.

- a. Air handling unit and all other fans, cubic meters/min (cubic feet per minute): Minus 0 percent to plus 10 percent.
- b. Air terminal units (maximum values): Minus 2 percent to plus 10 percent.
- c. Exhaust hoods/cabinets: 0 percent to plus 10 percent.
- d. Minimum outside air: 0 percent to plus 10 percent.
- e. Individual room air outlets and inlets, and air flow rates not mentioned above: Minus 2 percent to plus 10 percent except if the air to a space is 100 CFM or less the tolerance would be 0 to plus 5 percent.
- f. Heating hot water pumps and hot water coils: Minus 5 percent to plus 5 percent.
- g. Chilled water and condenser water pumps: 0 percent to plus 5 percent.
- h. Chilled water coils: 0 percent to plus 5 percent.
- 3. Systems shall be adjusted for energy efficient operation as described in PART 3.
- 4. Typical TAB procedures and results shall be demonstrated to the Contracting Officer Technical Representative for one air distribution system (including all fans, three terminal units, three rooms) and one hydronic system (pumps and three coils) as follows:
 - a. When field TAB work begins.
 - b. During each partial final inspection and the final inspection for the project if requested by VA.

1.4 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Submit names and qualifications of TAB agency and TAB specialists within 60 days after the notice to proceed. Submit information on three recently completed projects and a list of proposed test equipment.
- C. For use by the Contracting Officer Technical Representative staff, submit one complete set of applicable AABC or NEBB publications that will be the basis of TAB work.
- D. Submit Following for Review and Approval:
 - 1. Design Review Report within 90 calendar days for conventional design projects after the system layout on air and water side is completed by the Contractor.

2. Systems inspection report on equipment and installation for conformance with design.
 3. Duct Air Leakage Test Report.
 4. Systems Readiness Report.
 5. Intermediate and Final TAB reports covering flow balance and adjustments, performance tests, vibration tests and sound tests.
 6. Include in final reports uncorrected installation deficiencies noted during TAB and applicable explanatory comments on test results that differ from design requirements.
- E. Prior to request for Final or Partial Final inspection, submit completed Test and Balance report for the area.

1.5 APPLICABLE PUBLICATIONS

- A. The following publications form a part of this specification to the extent indicated by the reference thereto. In text the publications are referenced to by the acronym of the organization.
- B. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE):
 2003.....HVAC Applications ASHRAE Handbook, Chapter 37,
 Testing, Adjusting, and Balancing and Chapter
 47, Sound and Vibration Control
- C. Associated Air Balance Council (AABC):
 2002.....AABC National Standards for Total System
 Balance
- D. National Environmental Balancing Bureau (NEBB):
 7th Edition 2005Procedural Standards for Testing, Adjusting,
 Balancing of Environmental Systems
 1st Edition 1994Procedural Standards for the Measurement and
 Assessment of Sound and Vibration
 2nd Edition 1999Procedural Standards for Building Systems
 Commissioning
- E. Sheet Metal and Air Conditioning Contractors National Association
 (SMACNA):
 3rd Edition 2002HVAC SYSTEMS-Testing, Adjusting and Balancing

PART 2 - PRODUCTS

2.1 PLUGS

Provide plastic plugs to seal holes drilled in ductwork for test purposes.

2.2 INSULATION REPAIR MATERIAL

See Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION.

Provide for repair of insulation removed or damaged for TAB work.

PART 3 - EXECUTION

3.1 GENERAL

- A. Refer to TAB Criteria in Article, Quality Assurance.
- B. Obtain applicable contract documents and copies of approved submittals for HVAC equipment and automatic control systems.

3.2 DESIGN REVIEW REPORT

The TAB Specialist shall review the Contract Plans and specifications and advise the Contracting Officer Technical Representative of any design deficiencies that would prevent the HVAC systems from effectively operating in accordance with the sequence of operation specified or prevent the effective and accurate TAB of the system. The TAB Specialist shall provide a report individually listing each deficiency and the corresponding proposed corrective action necessary for proper system operation.

3.3 SYSTEMS INSPECTION REPORT

- A. Inspect equipment and installation for conformance with design.
- B. The inspection and report is to be done after air distribution equipment is on site and duct installation has begun, but well in advance of performance testing and balancing work. The purpose of the inspection is to identify and report deviations from design and ensure that systems will be ready for TAB at the appropriate time.
- C. Reports: Follow check list format developed by AABC, NEBB or SMACNA, supplemented by narrative comments, with emphasis on air handling units and fans. Check for conformance with submittals. Verify that diffuser and register sizes are correct. Check air terminal unit installation including their duct sizes and routing.

3.4 DUCT AIR LEAKAGE TEST REPORT

See paragraphs "Duct leakage Tests and Repairs" in Section 23 31 00, HVAC DUCTS AND CASINGS for TAB agency's role and responsibilities in witnessing, recording and reporting of deficiencies.

3.5 SYSTEM READINESS REPORT

- A. Inspect each System to ensure that it is complete including installation and operation of controls.

- B. Verify that all items such as ductwork piping, ports, terminals, connectors, etc., that is required for TAB are installed. Provide a report to the Contracting Officer Technical Representative.

3.6 TAB REPORTS

- A. Submit an intermediate report for 50 percent of systems and equipment tested and balanced to establish satisfactory test results.
- B. The TAB contractor shall provide raw data immediately in writing to the Contracting Officer Technical Representative if there is a problem in achieving intended results before submitting a formal report.
- C. If over 20 percent of readings in the intermediate report fall outside the acceptable range, the TAB report shall be considered invalid and all contract TAB work shall be repeated and re-submitted for approval.
- D. Do not proceed with the remaining systems until intermediate report is approved by the Contracting Officer Technical Representative.

3.7 TAB PROCEDURES

- A. Tab shall be performed in accordance with the requirement of the Standard under which TAB agency is certified by either AABC or NEBB.
- B. General: During TAB all related system components shall be in full operation. Fan and pump rotation, motor loads and equipment vibration shall be checked and corrected as necessary before proceeding with TAB. Set controls and/or block off parts of distribution systems to simulate design operation of variable volume air or water systems for test and balance work.
- C. Coordinate TAB procedures with any phased construction completion requirements for the project. Provide TAB reports for each phase of the project prior to partial final inspections of each phase of the project.
- D. Allow sufficient time in construction schedule for TAB and submission of all reports for an organized and timely correction of deficiencies.
- E. Air Balance and Equipment Test: Include air handling units, fans, terminal units, room diffusers/outlets/inlets, and kitchen exhaust hoods.
 - 1. Artificially load air filters by partial blanking to produce air pressure drop of at least 90 percent of the design final pressure drop.
 - 2. Adjust fan speeds to provide design air flow. V-belt drives, including fixed pitch pulley requirements, are specified in Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

3. Test and balance systems in all specified modes of operation, including variable volume, economizer, and fire emergency modes. Verify that dampers and other controls function properly.
 4. Variable air volume (VAV) systems:
 - a. Coordinate TAB, including system volumetric controls, with Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
 - b. Section 23 36 00, AIR TERMINAL UNITS, specifies that maximum and minimum flow rates for air terminal units (ATU) be factory set. Check and readjust ATU flow rates if necessary. Balance air distribution from ATU on full cooling maximum scheduled cubic meters per minute (cubic feet per minute). Reset room thermostats and check ATU operation from maximum to minimum cooling, to the heating mode, and back to cooling. Record and report the heating coil leaving air temperature when the ATU is in the maximum heating mode.
 5. Record final measurements for air handling equipment performance data sheets.
- F. Water Balance and Equipment Test: Include coils:
1. Adjust flow rates for equipment. Set coils and evaporator to values on equipment submittals, if different from values on contract drawings.
 2. Record final measurements for hydronic equipment on performance data sheets. Include entering and leaving water temperatures for heating and cooling coils, and for convertors. Include entering and leaving air temperatures (DB/WB for cooling coils) for air handling units and reheat coils. Make air and water temperature measurements at the same time.

3.8 VIBRATION TESTING

- A. Furnish instruments and perform vibration measurements as specified in Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT. Field vibration balancing is specified in Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION. Provide measurements for all rotating HVAC equipment of 373 watts (1/2 horsepower) and larger, including centrifugal/screw compressors, cooling towers, pumps, fans and motors.
- B. Record initial measurements for each unit of equipment on test forms and submit a report to the Contracting Officer Technical Representative. Where vibration readings exceed the allowable tolerance

Contractor shall be directed to correct the problem. The TAB agency shall verify that the corrections are done and submit a final report to the Contracting Officer Technical Representative.

3.9 SOUND TESTING

- A. Perform and record required sound measurements in accordance with Paragraph, QUALITY ASSURANCE in Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.
 - 1. Take readings in rooms, approximately fifteen (15) percent of all rooms. The Contracting Officer Technical Representative may designate the specific rooms to be tested.
- B. Take measurements with a calibrated sound level meter and octave band analyzer of the accuracy required by AABC or NEBB.
- C. Sound reference levels, formulas and coefficients shall be according to ASHRAE Handbook, "HVAC Applications", Chapter 46, SOUND AND VIBRATION CONTROL.
- D. Determine compliance with specifications as follows:
 - 1. When sound pressure levels are specified, including the NC Criteria in Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT:
 - a. Reduce the background noise as much as possible by shutting off unrelated audible equipment.
 - b. Measure octave band sound pressure levels with specified equipment "off."
 - c. Measure octave band sound pressure levels with specified equipment "on."
 - d. Use the DIFFERENCE in corresponding readings to determine the sound pressure due to equipment.

DIFFERENCE:	0	1	2	3	4	5 to 9	10 or More
FACTOR:	10	7	4	3	2	1	0

Sound pressure level due to equipment equals sound pressure level with equipment "on" minus FACTOR.

- e. Plot octave bands of sound pressure level due to equipment for typical rooms on a graph which also shows noise criteria (NC) curves.
- 2. When sound power levels are specified:
 - a. Perform steps 1.a. thru 1.d., as above.

- b. For indoor equipment: Determine room attenuating effect, i.e., difference between sound power level and sound pressure level. Determined sound power level will be the sum of sound pressure level due to equipment plus the room attenuating effect.
 - c. For outdoor equipment: Use directivity factor and distance from noise source to determine distance factor, i.e., difference between sound power level and sound pressure level. Measured sound power level will be the sum of sound pressure level due to equipment plus the distance factor. Use 13 meters (40 feet) for sound level location.
3. Where sound pressure levels are specified in terms of dB(A), as in Section 23 65 00, COOLING TOWERS, measure sound levels using the "A" scale of meter. Single value readings will be used instead of octave band analysis.
- E. Where measured sound levels exceed specified level, the installing contractor or equipment manufacturer shall take remedial action approved by the Contracting Officer Technical Representative and the necessary sound tests shall be repeated.

3.10 MARKING OF SETTINGS

Following approval of Tab final Report, the setting of all HVAC adjustment devices including valves, splitters and dampers shall be permanently marked by the TAB Specialist so that adjustment can be restored if disturbed at any time. Style and colors used for markings shall be coordinated with the Contracting Officer Technical Representative.

3.11 IDENTIFICATION OF TEST PORTS

The TAB Specialist shall permanently and legibly identify the location points of duct test ports. If the ductwork has exterior insulation, the identification shall be made on the exterior side of the insulation. All penetrations through ductwork and ductwork insulation shall be sealed to prevent air leaks and maintain integrity of vapor barrier.

- - - E N D - - -

SECTION 23 07 11
HVAC, PLUMBING, AND BOILER PLANT INSULATION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Field applied insulation for thermal efficiency and condensation control for
 - 1. HVAC piping, ductwork and equipment.
 - 2. Plumbing piping and equipment.
- B. Definitions
 - 1. ASJ: All service jacket, white finish facing or jacket.
 - 2. Air conditioned space: Space having air temperature and/or humidity controlled by mechanical equipment.
 - 3. Cold: Equipment, ductwork or piping handling media at design temperature of 16 degrees C (60 degrees F) or below.
 - 4. Concealed: Ductwork and piping above ceilings and in chases, and pipe spaces.
 - 5. Exposed: Piping, ductwork, and equipment exposed to view in finished areas including mechanical, Boiler Plant and electrical equipment rooms or exposed to outdoor weather. Attics and crawl spaces where air handling units are located are considered to be mechanical rooms. Shafts, chases, unfinished attics, crawl spaces and pipe basements are not considered finished areas.
 - 6. FSK: Foil-scrim-kraft facing.
 - 7. Hot: HVAC Ductwork handling air at design temperature above 16 degrees C (60 degrees F); HVAC and plumbing equipment or piping handling media above 41 degrees C (105 degrees F); Boiler Plant breechings and stack temperature range 150-370 degrees C (300-700 degrees F) and piping media and equipment 32 to 230 degrees C (90 to 450 degrees F)
 - 8. Density: kg/m^3 - kilograms per cubic meter (Pcf - pounds per cubic foot).
 - 9. Runouts: Branch pipe connections up to 25-mm (one-inch) nominal size to fan coil units or reheat coils for terminal units.
 - 10. Thermal conductance: Heat flow rate through materials.
 - a. Flat surface: Watt per square meter (BTU per hour per square foot).
 - b. Pipe or Cylinder: Watt per square meter (BTU per hour per linear foot).

11. Thermal Conductivity (k): Watt per meter, per degree C (BTU per inch thickness, per hour, per square foot, per degree F temperature difference).
12. LPS: Low pressure steam (103 kPa [15 psig] and below).
13. LPR: Low pressure steam condensate gravity return.
14. HWH: Hot water heating supply.
15. HWHR: Hot water heating return.
16. CW: Cold water.
17. SW: Soft water.
18. HW: Hot water.
19. CH: Chilled water supply.
20. CHR: Chilled water return.
21. RS: Refrigerant suction.
22. PVDC: Polyvinylidene chloride vapor retarder jacketing, white.

1.2 RELATED WORK

- A. Section 07 84 00, FIRESTOPPING: Mineral fiber and bond breaker behind sealant.
- B. Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION: General mechanical requirements and items, which are common to more than one section of Division 23.
- C. Section 23 23 00, REFRIGERANT PIPING: Requirements for refrigerant piping and fittings.
- D. Section 23 21 13, HYDRONIC PIPING and Section 23 22 13, STEAM AND CONDENSATE HEATING PIPING: Piping and equipment.
- E. Section 23 21 13, HYDRONIC PIPING: Chilled water piping.
- F. Section 23 31 00, HVAC DUCTS AND CASINGS: Ductwork, plenum and fittings.

1.3 QUALITY ASSURANCE

- A. Refer to article QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.
- B. Criteria:
 1. Comply with NFPA 90A, particularly paragraphs 4.3.3.1 through 4.3.3.6, 4.3.10.2.6, and 5.4.6.4, parts of which are quoted as follows:

4.3.3.1 Pipe insulation and coverings, duct coverings, duct linings, vapor retarder facings, adhesives, fasteners, tapes, and supplementary materials added to air ducts, plenums, panels, and duct silencers used in duct systems, unless otherwise provided for in 4.3.3.1.2 or 4.3.3.1.3, shall have, in the form in which they are used, a maximum flame spread index of 25 without evidence of continued progressive combustion and a maximum smoke developed index of 50 when tested in accordance with NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials*.

4.3.3.1.1 Where these products are to be applied with adhesives, they shall be tested with such adhesives applied, or the adhesives used shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when in the final dry state. (See 4.2.4.2.)

4.3.3.1.2 The flame spread and smoke developed index requirements of 4.3.3.1.1 shall not apply to air duct weatherproof coverings where they are located entirely outside of a building, do not penetrate a wall or roof, and do not create an exposure hazard.

4.3.3.1.3 Smoke detectors required by 6.4.4 shall not be required to meet flame spread index or smoke developed index requirements.

4.3.3.2 Closure systems for use with rigid and flexible air ducts tested in accordance with UL 181, Standard for Safety Factory-Made Air Ducts and Air Connectors, shall have been tested, listed, and used in accordance with the conditions of their listings, in accordance with one of the following:

- (1) UL 181A, Standard for Safety Closure Systems for Use with Rigid Air Ducts and Air Connectors
- (2) UL 181B, Standard for Safety Closure Systems for Use with Flexible Air Ducts and Air Connectors

4.3.3.3 Air duct, panel, and plenum coverings and linings, and pipe insulation and coverings shall not flame, glow, smolder, or smoke when tested in accordance with a similar test for pipe covering, ASTM C 411, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation, at the temperature to which they are exposed in service.

4.3.3.3.1 In no case shall the test temperature be below 121°C (250°F).

4.3.3.4 Air duct coverings shall not extend through walls or floors that are required to be fire stopped or required to have a fire resistance rating, unless such coverings meet the requirements of 5.4.6.4.

4.3.3.5* Air duct linings shall be interrupted at fire dampers to prevent interference with the operation of devices.

4.3.3.6 Air duct coverings shall not be installed so as to conceal or prevent the use of any service opening.

4.3.10.2.6 Materials exposed to the airflow shall be noncombustible or limited combustible and have a maximum smoke developed index of 50 or comply with the following.

4.3.10.2.6.1 Electrical wires and cables and optical fiber cables shall be listed as noncombustible or limited combustible and have a maximum smoke developed index of 50 or shall be listed as having a maximum peak optical density of 0.5 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.5 m (5 ft) or less when tested in accordance with NFPA 262, Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.

4.3.10.2.6.2 Pneumatic tubing for control systems shall be listed as having a maximum peak optical density of 0.5 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.5 m (5 ft) or less when tested in accordance with UL 1820, Standard for Safety Fire Test of Pneumatic Tubing for Flame and Smoke Characteristics.

4.3.10.2.6.3 Nonferrous fire sprinkler piping shall be listed as having a maximum peak optical density of 0.5 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.5 m (5 ft) or less when tested in accordance with UL 1887, Standard for Safety Fire Test of Plastic Sprinkler Pipe for Visible Flame and Smoke Characteristics.

4.3.10.2.6.4 Optical-fiber and communication raceways shall be listed as having a maximum peak optical density of 0.5 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.5 m (5 ft) or less when tested in accordance with UL 2024, Standard for Safety Optical-Fiber Cable Raceway.

4.3.10.2.6.5 Loudspeakers and recessed lighting fixtures, including their assemblies and accessories, shall be permitted in the ceiling cavity plenum where listed as having a maximum peak optical density of 0.5 or less, an average optical density of 0.15 or less, and a peak heat release rate of 100 kW or less when tested in accordance with UL 2043, Standard for Safety Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces.

4.3.10.2.6.6 Supplementary materials for air distribution systems shall be permitted when complying with the provisions of 4.3.3.

4.3.10.2.6.7 Smoke detectors shall not be required to meet the provisions of this section.

5.4.6.4 Where air ducts pass through walls, floors, or partitions that are required to have a fire resistance rating and where fire dampers are not required, the opening in the construction around the air duct shall be as follows:

- (1) Not exceeding a 25.4 mm (1 in.) average clearance on all sides
- (2) Filled solid with an approved material capable of preventing the passage of flame and hot gases sufficient to ignite cotton waste when subjected to the time-temperature fire conditions required for fire barrier penetration as specified in NFPA 251, *Standard Methods of Tests of Fire Endurance of Building Construction and Materials*

2. Test methods: ASTM E84, UL 723, or NFPA 255.

3. Specified k factors are at 24 degrees C (75 degrees F) mean temperature unless stated otherwise. Where optional thermal insulation material is used, select thickness to provide thermal conductance no greater than that for the specified material. For pipe, use insulation manufacturer's published heat flow tables. For domestic hot water supply and return, run out insulation and condensation control insulation, no thickness adjustment need be made.
 4. All materials shall be compatible and suitable for service temperature, and shall not contribute to corrosion or otherwise attack surface to which applied in either the wet or dry state.
- C. Every package or standard container of insulation or accessories delivered to the job site for use must have a manufacturer's stamp or label giving the name of the manufacturer and description of the material.

1.4 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Shop Drawings:
 1. All information, clearly presented, shall be included to determine compliance with drawings and specifications and ASTM, federal and military specifications.
 - a. Insulation materials: Specify each type used and state surface burning characteristics.
 - b. Insulation facings and jackets: Each type used. Make it clear that white finish will be furnished for exposed ductwork, casings and equipment.
 - c. Insulation accessory materials: Each type used.
 - d. Manufacturer's installation and fitting fabrication instructions for flexible unicellular insulation.
 - e. Make reference to applicable specification paragraph numbers for coordination.

1.5 STORAGE AND HANDLING OF MATERIAL

Store materials in clean and dry environment, pipe covering jackets shall be clean and unmarred. Place adhesives in original containers. Maintain ambient temperatures and conditions as required by printed instructions of manufacturers of adhesives, mastics and finishing cements.

1.6 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by basic designation only.
- B. Federal Specifications (Fed. Spec.):
- L-P-535E (2)-91.....Plastic Sheet (Sheeting): Plastic Strip; Poly (Vinyl Chloride) and Poly (Vinyl Chloride - Vinyl Acetate), Rigid.
- C. Military Specifications (Mil. Spec.):
- MIL-A-3316C (2)-90.....Adhesives, Fire-Resistant, Thermal Insulation
- MIL-A-24179A (1)-87.....Adhesive, Flexible Unicellular-Plastic Thermal Insulation
- MIL-C-19565C (1)-88.....Coating Compounds, Thermal Insulation, Fire-and Water-Resistant, Vapor-Barrier
- MIL-C-20079H-87.....Cloth, Glass; Tape, Textile Glass; and Thread, Glass and Wire-Reinforced Glass
- D. American Society for Testing and Materials (ASTM):
- C449-00.....Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement
- C533-04.....Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation
- C534-05.....Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
- C547-06.....Standard Specification for Mineral Fiber pipe Insulation
- C552-03.....Standard Specification for Cellular Glass Thermal Insulation
- C553-02.....Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
- C585-90.....Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System) R (1998)
- C612-04.....Standard Specification for Mineral Fiber Block and Board Thermal Insulation

- C1126-04.....Standard Specification for Faced or Unfaced
Rigid Cellular Phenolic Thermal Insulation
- C1136-06.....Standard Specification for Flexible, Low
Permeance Vapor Retarders for Thermal
Insulation
- E84-06.....Standard Test Method for Surface Burning
Characteristics of Building
Materials
- E. National Fire Protection Association (NFPA):
- 90A-02.....Installation of Air Conditioning and
Ventilating Systems
- 96-04.....Standards for Ventilation Control and Fire
Protection of Commercial Cooking Operations
- 101-06.....Life Safety Code
- 255-06.....Standard Method of tests of Surface Burning
Characteristics of Building Materials
- F. Underwriters Laboratories, Inc (UL):
- 723.....UL Standard for Safety Test for Surface Burning
Characteristics of Building Materials with
Revision of 08/03
- G. Manufacturer's Standardization Society of the Valve and Fitting
Industry (MSS):
- SP58-2002.....Pipe Hangers and Supports Materials, Design,
and Manufacture

PART 2 - PRODUCTS

2.1 MINERAL FIBER

- A. ASTM C612 (Board, Block), Class 1 or 2, $k = 0.037$ Watt per meter, per degree C (0.26), external insulation for temperatures up to 204 degrees C (400 degrees F).
- B. ASTM C553 (Blanket, Flexible) Type I, Class B-5, Density 32 kg/m^3 (2 pcf), $k = 0.04$ (0.27), for use at temperatures up to 204 degrees C (400 degrees F)
- C. ASTM C547 (Pipe Fitting Insulation and Preformed Pipe Insulation), Class 1, $k = 0.037$ (0.26) for use at temperatures 230 degrees C (450 degrees F).

2.2 MINERAL WOOL OR REFRACTORY FIBER

Comply with Standard ASTM C612, Class 3, 450 degrees C (850 degrees F).

2.3 RIGID CELLULAR PHENOLIC FOAM

- A. Preformed (molded) pipe insulation, ASTM C1126, type III, grade 1, $k = 0.021(0.15)$, for temperatures up to 121 degrees C (250 degrees F) with vapor retarder and all service jacket with polyvinyl chloride premolded fitting covering.
- B. Equipment and Duct Insulation, ASTM C 1126, type II, grade 1, $k = 0.021(0.15)$, for temperatures up to 121 degrees C (250 degrees F) with rigid cellular phenolic insulation and covering, vapor retarder and all service jacket.

2.4 CELLULAR GLASS CLOSED-CELL

- A. Comply with Standard ASTM C177, C518, density 120 kg/m³ (7.5 pcf) nominal, $k = 0.033(0.29)$ at 0 degrees C (75 degrees F).
- B. Pipe insulation for temperatures up to 200 degrees C (400 degrees F).

2.5 POLYISOCYANURATE CLOSED-CELL RIGID

- A. Preformed (fabricated) pipe insulation, ASTM C591, type IV, $K=0.027(0.19)$, for use at temperatures up to 149 degree C (300 degree F) with factory applied PVDC or all service jacket vapor retarder with polyvinyl chloride premolded fitting covers.
- B. Equipment and duct insulation, ASTM C 591, type IV, $K=0.027(0.19)$, for use at temperatures up to 149 degrees C (300 degrees F) with PVDC or all service jacket vapor retarder jacket.

2.6 FLEXIBLE ELASTOMERIC CELLULAR THERMAL

ASTM C177, C518, $k = 0.039$ Watt per meter, per degree C (0.27), at 24 degrees C (75 degrees F), flame spread not over 25, smoke developed not over 50, for temperatures from minus 4 degrees C (40 degrees F) to 93 degrees C (200 degrees F). No jacket required.

2.7 DUCT WRAP FOR KITCHEN HOOD GREASE DUCTS

- A. Light weight, high temperature mineral fiber or ceramic fiber insulating material with low thermal conductivity K value of 0.060 W/m² degrees C (0.417 Btu in/hr ft² degrees F) at mean temperature of 260 degrees C (500 degrees F).
- B. Material shall be fully encapsulated by UL classified aluminum foil and tested to ASTM E84 standard.
- C. Material shall be UL tested for internal grease fire to 1093 degrees C (2,000 degrees F) with zero clearance and for through-penetration firestop.

- D. Material shall be UL classified for 2 hour fire rating for grease duct enclosure, and meet NFPA 96 requirements for direct applied insulating material to grease ducts with zero clearance.
- E. Material flame spread and smoke developed ratings shall not be higher than 5, as per ASTM E 84/UL 723 Flammability Test.

2.8 CALCIUM SILICATE

- A. Preformed pipe Insulation: ASTM C533, Type I and Type II with indicator denoting asbestos-free material.
- B. Premolded Pipe Fitting Insulation: ASTM C533, Type I and Type II with indicator denoting asbestos-free material.
- C. Equipment Insulation: ASTM C533, Type I and Type II
- D. Characteristics:

Insulation Characteristics		
ITEMS	TYPE I	TYPE II
Temperature, maximum degrees C (degrees F)	649 (1200)	927 (1700)
Density (dry), Kg/m ³ (lb/ ft ³)	232 (14.5)	288 (18)
Thermal conductivity: Min W/ m K (Btu in/h ft ² degrees F)@ mean temperature of 93 degrees C (200 degrees F)	0.059 (0.41)	0.078 (0.540)
Surface burning characteristics:		
Flame spread Index, Maximum	0	0
Smoke Density index, Maximum	0	0

2.9 INSULATION FACINGS AND JACKETS

- A. Vapor Retarder, higher strength with low water permeance \leq 0.02 or less perm rating, Beach puncture 50 units for insulation facing on exposed ductwork, casings and equipment, and for pipe insulation jackets. Facings and jackets shall be all service type (ASJ) or PVDC Vapor Retarder jacketing.
- B. ASJ jacket shall be white kraft bonded to 0.025 mm (1 mil) thick aluminum foil, fiberglass reinforced, with pressure sensitive adhesive closure. Comply with ASTM C1136. Beach puncture 5 units, Suitable for painting without sizing. Jackets shall have minimum 40 mm (1-1/2 inch) lap on longitudinal joints and minimum 100 mm (4 inch) butt strip on

end joints. Butt strip material shall be same as the jacket. Lap and butt strips shall be self-sealing type with factory-applied pressure sensitive adhesive.

- C. Vapor Retarder medium strength with low water vapor permeance of 0.02 or less perm rating), Beach puncture 25 units: Foil-Scrim-Kraft (FSK) or PVDC vapor retarder jacketing type for concealed ductwork and equipment.
- D. Factory composite materials may be used provided that they have been tested and certified by the manufacturer.
- E. Pipe fitting insulation covering (jackets): Fitting covering shall be premolded to match shape of fitting and shall be polyvinyl chloride (PVC) conforming to Fed Spec L-P-335, composition A, Type II Grade GU, and Type III, minimum thickness 0.7 mm (0.03 inches). Provide color matching vapor retarder pressure sensitive tape.

2.10 PIPE COVERING PROTECTION SADDLES

- A. Cold pipe support: Premolded pipe insulation 180 degrees (half-shells) on bottom half of pipe at supports. Material shall be cellular glass or high density Polyisocyanurate insulation of the same thickness as adjacent insulation. Density of Polyisocyanurate insulation shall be a minimum of 48 kg/m³ (3.0 pcf).

Nominal Pipe Size and Accessories Material (Insert Blocks)	
Nominal Pipe Size mm (inches)	Insert Blocks mm (inches)
Up through 125 (5)	150 (6) long
150 (6)	150 (6) long
200 (8), 250 (10), 300 (12)	225 (9) long
350 (14), 400 (16)	300 (12) long
450 through 600 (18 through 24)	350 (14) long

- B. Warm or hot pipe supports: Premolded pipe insulation (180 degree half-shells) on bottom half of pipe at supports. Material shall be high density Polyisocyanurate (for temperatures up to 149 degrees C [300 degrees F]), cellular glass or calcium silicate. Insulation at supports shall have same thickness as adjacent insulation. Density of Polyisocyanurate insulation shall be a minimum of 48 kg/m³ (3.0 pcf).

2.11 ADHESIVE, MASTIC, CEMENT

- A. Mil. Spec. MIL-A-3316, Class 1: Jacket and lap adhesive and protective finish coating for insulation.

- B. Mil. Spec. MIL-A-3316, Class 2: Adhesive for laps and for adhering insulation to metal surfaces.
- C. Mil. Spec. MIL-A-24179, Type II Class 1: Adhesive for installing flexible unicellular insulation and for laps and general use.
- D. Mil. Spec. MIL-C-19565, Type I: Protective finish for outdoor use.
- E. Mil. Spec. MIL-C-19565, Type I or Type II: Vapor barrier compound for indoor use.
- F. ASTM C449: Mineral fiber hydraulic-setting thermal insulating and finishing cement.
- G. Other: Insulation manufacturers' published recommendations.

2.12 MECHANICAL FASTENERS

- A. Pins, anchors: Welded pins, or metal or nylon anchors with tin-coated or fiber washer, or clips. Pin diameter shall be as recommended by the insulation manufacturer.
- B. Staples: Outward clinching monel or stainless steel.
- C. Wire: 1.3 mm thick (18 gage) soft annealed galvanized or 1.9 mm (14 gage) copper clad steel or nickel copper alloy.
- D. Bands: 20 mm (3/4 inch) nominal width, brass, galvanized steel, aluminum or stainless steel.

2.13 REINFORCEMENT AND FINISHES

- A. Glass fiber fitting tape: Mil. Spec MIL-C-20079, Type II, Class 1.
- B. Tape for Flexible Elastomeric Cellular Insulation: As recommended by the insulation manufacturer.
- C. Corner beads: 50 mm (2 inch) by 50 mm (2 inch), 0.55 mm thick (26 gage) galvanized steel; or, 25 mm (1 inch) by 25 mm (1 inch), 0.47 mm thick (28 gage) aluminum angle adhered to 50 mm (2 inch) by 50 mm (2 inch) Kraft paper.
- D. PVC fitting cover: Fed. Spec L-P-535, Composition A, 11-86 Type II, Grade GU, with Form B Mineral Fiber insert, for media temperature 4 degrees C (40 degrees F) to 121 degrees C (250 degrees F). Below 4 degrees C (40 degrees F) and above 121 degrees C (250 degrees F). Provide double layer insert. Provide color matching vapor barrier pressure sensitive tape.

2.14 FIRESTOPPING MATERIAL

Other than pipe and duct insulation, refer to Section 07 84 00 FIRESTOPPING.

2.15 FLAME AND SMOKE

Unless shown otherwise all assembled systems shall meet flame spread 25 and smoke developed 50 rating as developed under ASTM, NFPA and UL standards and specifications. See paragraph 1.3 "Quality Assurance".

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

- A. Required pressure tests of duct and piping joints and connections shall be completed and the work approved by the Contracting Officer Technical Representative for application of insulation. Surface shall be clean and dry with all foreign materials, such as dirt, oil, loose scale and rust removed.
- B. Except for specific exceptions, insulate entire specified equipment, piping (pipe, fittings, valves, accessories), and duct systems. Insulate each pipe and duct individually. Do not use scrap pieces of insulation where a full length section will fit.
- C. Insulation materials shall be installed in a first class manner with smooth and even surfaces, with jackets and facings drawn tight and smoothly cemented down at all laps. Insulation shall be continuous through all sleeves and openings, except at fire dampers and duct heaters (NFPA 90A). Vapor retarders shall be continuous and uninterrupted throughout systems with operating temperature 16 degrees C (60 degrees F) and below. Lap and seal vapor barrier over ends and exposed edges of insulation. Anchors, supports and other metal projections through insulation on cold surfaces shall be insulated and vapor sealed for a minimum length of 150 mm (6 inches).
- D. Install vapor stops at all insulation terminations on either side of valves, pumps and equipment and particularly in straight lengths of pipe insulation.
- E. Insulation on hot piping and equipment shall be terminated square at items not to be insulated, access openings and nameplates. Cover all exposed raw insulation with white sealer or jacket material.
- F. Protect all insulations outside of buildings with aluminum jacket using lock joint or other approved system for a continuous weather tight system. Access doors and other items requiring maintenance or access shall be removable and sealable.

G. HVAC work not to be insulated:

1. Internally insulated ductwork and air handling units.
2. Relief air ducts (Economizer cycle exhaust air).
3. Exhaust air ducts and plenums, and ventilation exhaust air shafts.
4. In hot piping: Unions, flexible connectors, control valves, PRVs, safety valves and discharge vent piping, vacuum breakers, thermostatic vent valves, steam traps 20 mm (3/4 inch) and smaller, exposed piping through floor for convectors and radiators. Insulate piping to within approximately 75 mm (3 inches) of uninsulated items.

H. Plumbing work not to be insulated:

1. Piping and valves of fire protection system.
2. Chromium plated brass piping.
3. Water piping in contact with earth.
4. Small horizontal cold water branch runs in partitions to individual fixtures may be without insulation for maximum distance of 900 mm (3 feet).

I. Apply insulation materials subject to the manufacturer's recommended temperature limits. Apply adhesives, mastic and coatings at the manufacturer's recommended minimum coverage.

J. Elbows, flanges and other fittings shall be insulated with the same material as is used on the pipe straights. The elbow/ fitting insulation shall be field-fabricated, mitered or factory prefabricated to the necessary size and shape to fit on the elbow/ fitting. Use of polyurethane spray-foam to fill a PVC elbow jacket is prohibited on cold applications.

K. Firestop Pipe and Duct insulation:

1. Provide firestopping insulation at fire and smoke barriers through penetrations. Fire stopping insulation shall be UL listed as defines in Section 07 84 00, FIRESTOPPING.
2. Pipe and duct penetrations requiring fire stop insulation including, but not limited to the following:
 - a. Pipe risers through floors
 - b. Pipe or duct chase walls and floors
 - c. Smoke partitions
 - d. Fire partitions

L. Provide metal jackets over insulation as follows:

1. All piping and ducts exposed to outdoor weather.
2. Piping exposed in building, within 1800 mm (6 feet) of the floor, that connects to sterilizers, kitchen and laundry equipment. Jackets may be applied with pop rivets. Provide aluminum angle ring escutcheons at wall, ceiling or floor penetrations.
3. A 50 mm (2 inch) overlap is required at longitudinal and circumferential joints.

3.2 INSULATION INSTALLATION

A. Mineral Fiber Board:

1. Faced board: Apply board on pins spaced not more than 300 mm (12 inches) on center each way, and not less than 75 mm (3 inches) from each edge of board. In addition to pins, apply insulation bonding adhesive to entire underside of horizontal metal surfaces. Butt insulation edges tightly and seal all joints with laps and butt strips. After applying speed clips cut pins off flush and apply vapor seal patches over clips.
2. Plain board:
 - a. Insulation shall be scored, beveled or mitered to provide tight joints and be secured to equipment with bands spaced 225 mm (9 inches) on center for irregular surfaces or with pins and clips on flat surfaces. Use corner beads to protect edges of insulation.
 - b. For hot equipment: Stretch 25 mm (1 inch) mesh wire, with edges wire laced together, over insulation and finish with insulating and finishing cement applied in one coat, 6 mm (1/4 inch) thick, trowel led to a smooth finish.
 - c. For cold equipment: Apply meshed glass fabric in a tack coat 1.5 to 1.7 square meter per liter (60 to 70 square feet per gallon) of vapor mastic and finish with mastic at 0.3 to 0.4 square meter per liter (12 to 15 square feet per gallon) over the entire fabric surface.
3. Exposed, unlined ductwork and equipment in unfinished areas, mechanical and electrical equipment rooms and attics, and duct work exposed to outdoor weather:
 - a. 40 mm (1-1/2 inch) thick insulation faced with ASJ (white all service jacket): Supply air duct.
 - b. 25 mm (1 inch) thick insulation faced with ASJ: Return air duct.

- c. Outside air intake ducts: 25 mm (one inch) thick insulation faced with ASJ.
- 4. Hot equipment: 40 mm (1-1/2 inch) thick insulation faced with ASJ.
 - a. Booster water heaters for dietetics dish and pot washers and for washdown grease-extracting hoods.
- B. Flexible Mineral Fiber Blanket:
 - 1. Adhere insulation to metal with 100 mm (4 inch) wide strips of insulation bonding adhesive at 200 mm (8 inches) on center all around duct. Additionally secure insulation to bottom of ducts exceeding 600 mm (24 inches) in width with pins welded or adhered on 450 mm (18 inch) centers. Secure washers on pins. Butt insulation edges and seal joints with laps and butt strips. Staples may be used to assist in securing insulation. Seal all vapor retarder penetrations with mastic. Sagging duct insulation will not be acceptable. Install firestop duct insulation where required.
 - 2. Supply air ductwork to be insulated includes main and branch ducts from AHU discharge to room supply outlets, and the bodies of ceiling outlets to prevent condensation. Insulate sound attenuator units, coil casings and damper frames. To prevent condensation insulate trapeze type supports and angle iron hangers for flat oval ducts that are in direct contact with metal duct.
 - 3. Concealed supply air ductwork.
 - a. Above ceilings at a roof level: 50 mm (2 inch) thick insulation faced with FSK.
 - b. Above ceilings for other than roof level: 40 mm (1 ½ inch) thick insulation faced with FSK.
 - 4. Concealed return air duct above ceilings at a roof level, unconditioned areas, and in chases with external wall or containing steam piping; 40 mm (1-1/2 inch) thick, insulation faced with FSK. Concealed return air ductwork in other locations need not be insulated.
- C. Molded Mineral Fiber Pipe and Tubing Covering:
 - 1. Fit insulation to pipe or duct, aligning longitudinal joints. Seal longitudinal joint laps and circumferential butt strips by rubbing hard with a nylon sealing tool to assure a positive seal. Staples may be used to assist in securing insulation. Seal all vapor

- retarder penetrations on cold piping with a generous application of vapor barrier mastic. Provide inserts and install with metal insulation shields at outside pipe supports. Install freeze protection insulation over heating cable.
2. Contractor's options for fitting, flange and valve insulation:
 - a. Insulating and finishing cement for sizes less than 100 mm (4 inches) operating at surface temperature of 16 degrees C (61 degrees F) or more.
 - b. Factory premolded, one piece PVC covers with mineral fiber, (Form B), inserts. Provide two insert layers for pipe temperatures below 4 degrees C (40 degrees F), or above 121 degrees C (250 degrees F). Secure first layer of insulation with twine. Seal seam edges with vapor barrier mastic and secure with fitting tape.
 - c. Factory molded, ASTM C547 or field mitered sections, joined with adhesive or wired in place. For hot piping finish with a smoothing coat of finishing cement. For cold fittings, 16 degrees C (60 degrees F) or less, vapor seal with a layer of glass fitting tape imbedded between two 2 mm (1/16 inch) coats of vapor barrier mastic.
 - d. Fitting tape shall extend over the adjacent pipe insulation and overlap on itself at least 50 mm (2 inches).
 3. Nominal thickness in millimeters and inches specified in table below, for piping above ground:

Nominal Thickness of Molded Mineral Fiber Insulation				
Nominal Pipe Size, millimeters (inches):	25 (1) & below	32- 75 (1-1/4- 3)	100-150 (4-6)	200 (8) and above
a. 38-99 degrees C (100- 211 degrees F) (LPR, PC, HWH, HWHR, GH, GHR)	25 (1.0)	40 (1.5)	50 (2.0)	50 (2.0)
1. Runouts to air terminal unit reheat coils	15 (0.5)	-	-	-
b. Domestic hot water supply and return	15 (0.5)	20 (0.75)	25 (1.0)	40 (1.5)

D. Rigid Cellular Phenolic Foam:

1. Rigid closed cell phenolic insulation may be provided for piping, ductwork and equipment for temperatures up to 121 degrees C (250 degrees F).
2. Note the NFPA 90A burning characteristics requirements of 25/50 in paragraph 1.3.B
3. Provide secure attachment facilities such as welding pins.
4. Apply insulation with joints tightly drawn together
5. Apply adhesives, coverings, neatly finished at fittings, and valves.
6. Final installation shall be smooth, tight, neatly finished at all edges.
7. Minimum thickness in millimeters (inches) specified in table below, for piping above ground:

Nominal Thickness of Rigid Closed-Cell Phenolic Foam Insulation					
Nominal Pipe Size millimeters (inches):	25 (1) & below	32-75 (1 1/4-3)	100-150 (4-6)	200-300 (8-12)	350 (14) & above
1. 100-121 degrees C (212-250 degrees F), LPS, Vent piping from receivers and flash tanks.	15 (0.5)	25 (1)	25 (1)	--	--
2. 38-99 degrees C (100- 211 degrees F), LPR, PC, HWH, HWHR, GH and GHR.	15 (0.5)	20 (0.75)	25 (1)	--	--
a. Run outs to reheat coils.	15 (0.5)	--	--	--	--
3. 4-16 degrees C (40-60 degrees F), CH, CHR, GC, and GCR.	20 (0.75)	20 (0.75)	25 (1)	40 (1.5)	50 (2.0)
4. 10 degrees C (50 degrees F) and less, RS for DX refrigerants.	15 (0.5)	20 (0.75)	--	--	--
5. Domestic hot water supply and return.	15 (0.5)	15 (0.5)	20 (0.75)	20 (0.75)	--

8. Condensation control insulation: Minimum 20 mm (0.75 inch) thick for all pipe sizes.

a. HVAC: Cooling coil condensation piping to waste piping fixture or drain inlet. Omit insulation on plastic piping in mechanical rooms.

b. Plumbing piping as follows:

1) Body of roof and overflow drains horizontal runs and offsets (including elbows) of interior downspout piping in all areas above pipe basement.

2) Waste piping from electric water coolers and icemakers to drainage system.

3) Cold water piping.

E. Cellular Glass Insulation:

1. Pipe and tubing, covering nominal thickness in millimeters and inches as tabulated below for chilled water and refrigerant piping.

Nominal Thickness of Cellular Glass Insulation				
Millimeters (inches)	Thru 38 (1 1/2)	50- 150 (2-6)	200-300 (8-12)	over 350 (14)
1. 4-16 degrees C (40-60 degrees F) (CH and CHR within chiller room and pipe chase and underground)	50 (2.0)	80 (3.0)	80 (3.0)	100 (4.0)
2. 4-16 degrees C (40-60 degrees F) (CH and CHR outside chiller room)	40 (1.5)	50 (2.0)	50 (2.0)	65 (2.5)

F. Polyisocyanurate Closed-Cell Rigid Insulation:

1. Polyisocyanurate closed-cell rigid insulation (PIR) may be provided for piping, equipment and ductwork for temperature up to 149 degree C (300 degree F) provided insulation thickness requirement does not exceed 38 mm (1.5 inches).

2. Install insulation, vapor retarder and jacketing per manufacturer's recommendations. Particular attention should be paid to recommendations for joint staggering, adhesive application, external hanger design, expansion/contraction joint design and spacing and vapor retarder integrity.

3. Install insulation with all joints tightly butted (except expansion joints in hot applications).
4. For cold applications, vapor retarder shall be installed in a continuous manner. No staples, rivets, screws or any other attachment device capable of penetrating the vapor retarder shall be used to attach the vapor retarder or jacketing. No wire ties capable of penetrating the vapor retarder shall be used to hold the insulation in place. Banding shall be used to attach PVC or metal jacketing.
5. Elbows, flanges and other fittings shall be insulated with the same material as is used on the pipe straights. The elbow/ fitting insulation shall be field-fabricated, mitered or factory prefabricated to the necessary size and shape to fit on the elbow/ fitting. Use of polyurethane spray-foam to fill PVC elbow jacket is prohibited on cold applications.
6. For cold applications, the vapor retarder on elbows/fittings shall be either mastic-fabric-mastic or 2 mil thick PVDC vapor retarder adhesive tape.
7. All PVC and metal jacketing shall be installed so as to naturally shed water. Joints shall point down and shall be sealed with either adhesive or caulking (except for periodic slip joints).
8. Underground piping: Follow instructions for above ground piping but the vapor retarder jacketing shall be 6 mil thick PVDC or minimum 30 mil thick rubberized bituminous membrane. Sand bed and backfill shall be a minimum of 150 mm (6 inches) all around insulated pipe.
9. Note the NFPA 90A burning characteristic requirements of 25/50 in paragraph 1.3B. Refer to paragraph 3.1 for items not to be insulated.
10. Minimum thickness in millimeter (inches) specified in table below, for piping:

Nominal Thickness of Polyisocyanurate Rigid Insulation				
Nominal Pipe Size millimeters(inches):	25(1) & below	32-75 (1 1/4- 3)	100-150 (4-6)	200-300 (8-12)
1. 100-121 degrees C (211-250 degrees F), HPR, MPR, LPS, Vent piping from receivers and flash tanks	20 (0.75)	40(1.5)	40(1.5)	40(1.50)
2. 38-99 degrees C (100-211 degrees F), LPR, PC, HWH, HWHR, GH and GHR a. Run outs to reheat coils	20 (0.75) 20 (0.75)	25(1.0) --	40(1.5) --	40(1.50) --
3. 4-16 degrees C (40-60 degrees F), CH, CHR, GC and GCR for relative humidity up to 80 percent or underground location	25 (1.00)	25 (1.0)	40 (1.50)	40(1.5)
4. 4-16 degrees C(40-60 degrees F) CH, CHR, GC and GCR for relative humidity 80 to 90 percent or higher	40 (1.50)	40 (1.5)	40 (1.5)	40 (1.5)
5. 10 degrees C (50 degrees F) and less, RS for DX refrigerants	20 (0.75)	25 (1.0)	--	--
6. Domestic hot water supply and return	15 (0.5)	20 (0.74)	25 (1.0)	25(1.0)

11. Condensation control insulation: Minimum 20 mm (0.75 inch) thick for all pipe sizes.

a. HVAC: Cooling coil condensation piping to waste piping fixture or drain inlet. Omit insulation on plastic piping in mechanical rooms.

- b. Plumbing piping as follows:
 - 1) Body of roof and overflow drains and horizontal runs and offsets (including elbows) of interior downspout piping in all areas above pipe basement.
 - 2) Waste piping from electric water coolers to drainage system.
 - 7) Cold Water Piping.
- G. Flexible Elastomeric Cellular Thermal Insulation:
 - 1. Apply insulation and fabricate fittings in accordance with the manufacturer's installation instructions and finish with two coats of weather resistant finish as recommended by the insulation manufacturer.
 - 2. Pipe and tubing insulation:
 - a. Use proper size material. Do not stretch or strain insulation.
 - b. To avoid undue compression of insulation, provide cork stoppers or wood inserts at supports as recommended by the insulation manufacturer. Insulation shields are specified under Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.
 - c. Where possible, slip insulation over the pipe or tubing prior to connection, and seal the butt joints with adhesive. Where the slip-on technique is not possible, slit the insulation and apply it to the pipe sealing the seam and joints with contact adhesive. Optional tape sealing, as recommended by the manufacturer, may be employed. Make changes from mineral fiber insulation in a straight run of pipe, not at a fitting. Seal joint with tape.
 - 3. Apply sheet insulation to flat or large curved surfaces with 100 percent adhesive coverage. For fittings and large pipe, apply adhesive to seams only.
 - 4. Pipe insulation: nominal thickness in millimeters (inches as specified in table below for piping above ground:

Nominal Thickness of Flexible Elastomeric Cellular Insulation				
Nominal Pipe Size millimeters (inches)	25 (1) & below	32-75 (1 1/4-3)	100-150 (4-6)	200 (8)
1. 38-93 degrees C (100-200 degrees F) (HWH, HWHR, GH, GHR)	25 (1.0)	40 (1.5)	-	-
a. Runouts to air terminal unit reheat coils	20 (0.75)	40 (1.5)	-	-
2. 4-16 degrees C (40-60 degrees F) (CH, CHR, GC, GCR)	25 (1.0)	40 (1.5)	-	-
a. Runouts to cooling coil	20 (0.75)	40 (1.5)	-	-
b. RS for DX refrigeration	25 (1.0)	40 (1.5)	-	-
3. Domestic hot water supply and return	15 (0.50)	20 (0.75)	25 (1.0)	40 (1.50)

d. Piping inside refrigerators and freezers: Provide heat tape under insulation.

H. Duct Wrap for Kitchen Hood Grease Ducts:

1. The insulation thickness, layers and installation method shall be as per recommendations of the manufacturer to maintain the fire integrity and performance rating.
2. Provide stainless steel jacket for all exterior and exposed interior ductwork.

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**SECTION 23 08 00
COMMISSIONING OF HVAC SYSTEMS**

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The requirements of this Section apply to all sections of Division 23.
- B. This project will have selected building systems commissioned. The complete list of equipment and systems to be commissioned are specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. The commissioning process, which the Contractor is responsible to execute, is defined in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. A Commissioning Agent (CxA) appointed by the Department of Veterans Affairs will manage the commissioning process.

1.2 RELATED WORK

- A. Section 01 00 00 GENERAL REQUIREMENTS.
- B. Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.
- C. Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

1.3 SUMMARY

- A. This Section includes requirements for commissioning the HVAC systems, subsystems and equipment. This Section supplements the general requirements specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.
- B. The commissioning activities have been developed to support the VAMC requirements to meet guidelines for Federal Leadership in Environmental, Energy, and Economic Performance.
- C. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for more specifics regarding processes and procedures as well as roles and responsibilities for all Commissioning Team members.

1.4 DEFINITIONS

Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for definitions.

1.5 COMMISSIONED SYSTEMS

- A. Commissioning of a system or systems specified in this Division is part of the construction process. Documentation and testing of these systems, as well as training of the VA's Operation and Maintenance personnel, is required in cooperation with the VAMC and the Commissioning Agent.

B. The following HVAC systems will be commissioned:

1. Air Handling Systems (including terminal units and energy recovery units)
2. Air Handling Systems (Fans, motors, Variable Speed Drives, cooling coils and control valves, heating coils and control valves, filters, dampers, safeties such as smoke detectors or freezestats and damper end switches, controls, gages, and vibration isolation).
3. Exhaust Fans (Fan, motor, controls and safeties).
4. Direct Digital Control System (BACnet or similar Local Area Network (LAN), Operator Work Station hardware and software, building controller hardware and software, terminal unit controller hardware and software, all sequences of operation, system accuracy and response time).
5. Commercial Kitchen Hoods & Associated Fire Suppression Systems (Fans, motors, Variable Speed Drives, automatic shut down on fire suppression discharge, and gas valve operation).

1.6 SUBMITTALS

- A. The commissioning process requires review of selected Submittals. The Commissioning Agent will provide a list of submittals that will be reviewed by the Commissioning Agent. This list will be reviewed and approved by the VAMC prior to forwarding to the Contractor. Refer to Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, and SAMPLES for further details.
- B. The commissioning process requires Submittal review simultaneously with engineering review. Specific submittal requirements related to the commissioning process are specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PRE-FUNCTIONAL CHECKLISTS

The Contractor shall complete Pre-Functional Checklists to verify systems, subsystems, and equipment installation is complete and systems are ready for Systems Functional Performance Testing. The Commissioning Agent will prepare Pre-Functional Checklists to be used to document equipment installation. The Contractor shall complete the checklists. Completed checklists shall be submitted to the VAMC and to the Commissioning Agent for review. The Commissioning Agent may spot check a sample of completed checklists. If the Commissioning Agent

determines that the information provided on the checklist is not accurate, the Commissioning Agent will return the marked-up checklist to the Contractor for correction and resubmission. If the Commissioning Agent determines that a significant number of completed checklists for similar equipment are not accurate, the Commissioning Agent will select a broader sample of checklists for review. If the Commissioning Agent determines that a significant number of the broader sample of checklists is also inaccurate, all the checklists for the type of equipment will be returned to the Contractor for correction and resubmission. Refer to SECTION 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for submittal requirements for Pre-Functional Checklists, Equipment Startup Reports, and other commissioning documents.

3.2 CONTRACTORS TESTS

Contractor tests as required by other sections of Division 23 shall be scheduled and documented in accordance with Section 01 00 00 GENERAL REQUIREMENTS. The Commissioning Agent will witness selected Contractor tests. Contractor tests shall be completed prior to scheduling Systems Functional Performance Testing.

3.3 SYSTEMS FUNCTIONAL PERFORMANCE TESTING:

The Commissioning Process includes Systems Functional Performance Testing that is intended to test systems functional performance under steady state conditions, to test system reaction to changes in operating conditions, and system performance under emergency conditions. The Commissioning Agent will prepare detailed Systems Functional Performance Test procedures for review and approval by the Contracting Officer Technical Representative. The Contractor shall review and comment on the tests prior to approval. The Contractor shall provide the required labor, materials, and test equipment identified in the test procedure to perform the tests. The Commissioning Agent will witness and document the testing. The Contractor shall sign the test reports to verify tests were performed. See Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS, for additional details.

3.4 TRAINING OF VAMC PERSONNEL

Training of the VAMC's operation and maintenance personnel is required in cooperation with the Contracting Officer Technical Representative and Commissioning Agent. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel

concerning the location, operation, and troubleshooting of the installed systems. The instruction shall be scheduled in coordination with the Contracting Officer Technical Representative after submission and approval of formal training plans. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS and Division 23 Sections for additional Contractor training requirements.

----- END -----

SECTION 23 09 23
DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Control work shall be provided by Siemens Building Controls.
- B. Provide (a) direct-digital control system(s) as indicated on the project documents, point list, interoperability tables, drawings and as described in these specifications. Include a complete and working direct-digital control system. Include all engineering, programming, controls and installation materials, installation labor, commissioning and start-up, training, final project documentation and warranty.
 - 1. The direct-digital control system(s) shall consist of high-speed, peer-to-peer network of DDC controllers, a control system server, and an Engineering Control Center. Provide a remote user using a standard web browser to access the control system graphics and change adjustable setpoints with the proper password.
 - 2. The direct-digital control system(s) shall be native BACnet. All new workstations, controllers, devices and components shall be listed by BACnet Testing Laboratories. All new workstations, controller, devices and components shall be accessible using a Web browser interface and shall communicate exclusively using the ASHRAE Standard 135 BACnet communications protocol without the use of gateways, unless otherwise allowed by this Section of the technical specifications, specifically shown on the design drawings and specifically requested otherwise by the VAMC.
 - a. If used, gateways shall support the ASHRAE Standard 135 BACnet communications protocol.
 - b. If used, gateways shall provide all object properties and read/write services shown on VAMC-approved interoperability schedules.
 - 3. The work administered by this Section of the technical specifications shall include all labor, materials, special tools, equipment, enclosures, power supplies, software, software licenses, Project specific software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, submittals, testing, verification,

training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, Warranty, specified services and items required for complete and fully functional Controls Systems.

4. The control systems shall be designed such that each mechanical system shall operate under stand-alone mode. The contractor administered by this Section of the technical specifications shall provide controllers for each mechanical system. In the event of a network communication failure, or the loss of any other controller, the control system shall continue to operate independently. Failure of the ECC shall have no effect on the field controllers, including those involved with global strategies.
- B. Some products are furnished but not installed by the contractor administered by this Section of the technical specifications. The contractor administered by this Section of the technical specifications shall formally coordinate in writing and receive from other contractors formal acknowledgements in writing prior to submission the installation of the products. These products include the following:
1. Control valves.
 2. Flow switches.
 3. Flow meters.
 4. Sensor wells and sockets in piping.
 5. Terminal unit controllers.
- C. Some products are not provided by, but are nevertheless integrated with the work executed by, the contractor administered by this Section of the technical specifications. The contractor administered by this Section of the technical specifications shall formally coordinate in writing and receive from other contractors formal acknowledgements in writing prior to submission the particulars of the products. These products include the following:
1. Fire alarm systems. If zoned fire alarm is required by the project-specific requirements, this interface shall require multiple relays, which are provided and installed by the fire alarm system contractor, to be monitored.
 2. Terminal units' velocity sensors
 3. Variable frequency drives. These controls, if not native BACnet, will require a BACnet Gateway.

4. The following systems have limited control (as individually noted below) from the ECC:

- a. Constant temperature rooms: temperature out of acceptable range and status alarms.
- b. Food service coolers, refrigerators and freezers: in patient nutrition kitchens: high temperature, trending and status alarms.

D. Responsibility Table:

Work/Item/System	Furnish	Install	Low Voltage Wiring	Line Power
Control system low voltage and communication wiring	23 09 23	23 09 23	23 09 23	N/A
Terminal units	23	23	N/A	26
Controllers for terminal units	23 09 23	23	23 09 23	16
LAN conduits and raceway	23 09 23	23 09 23	N/A	N/A
Automatic dampers (not furnished with equipment)	23 09 23	23	N/A	N/A
Automatic damper actuators	23 09 23	23 09 23	23 09 23	23 09 23
Manual valves	23	23	N/A	N/A
Automatic valves	23 09 23	23	23 09 23	23 09 23
Pipe insertion devices and taps, flow and pressure stations.	23	23	N/A	N/A
Thermowells	23 09 23	23	N/A	N/A
Current Switches	23 09 23	23 09 23	23 09 23	N/A
Control Relays	23 09 23	23 09 23	23 09 23	N/A
Power distribution system monitoring interfaces	23 09 23	23 09 23	23 09 23	26
All control system nodes, equipment, housings, enclosures and panels.	23 09 23	23 09 23	23 09 23	26
Smoke detectors	28 31 00	28 31 00	28 31 00	28 31 00
Fire Dampers	23	23	N/A	N/A
VFDs	23 09 23	26	23 09 23	26
Fire Alarm shutdown relay interlock wiring	28	28	28	26
Starters, HOA switches	23	23	N/A	26

- E. This facility's existing direct-digital control system is manufactured by Siemens Building Technologies. The contractor administered by this Section of the technical specifications shall observe the capabilities, communication network, services, spare capacity of the existing control system and its ECC prior to beginning work.
1. Leave existing direct-digital control system intact and in place.
Provide a new ASHRAE Standard 135 BACnet-compliant ECC in the same room as the existing system's ECC, and provide a new BACnet-compliant control system serving the work in this project. Integrate new elements into existing architecture.
- F. This campus has standardized on an existing standard ASHRAE Standard 135, BACnet/IP Control System supported by a preselected controls service company. This entity is referred to as the "Control System Integrator" in this Section of the technical specifications. The Control system integrator is responsible for ECC system graphics and expansion. It also prescribes control system-specific commissioning/verification procedures to the contractor administered by this Section of the technical specification. It lastly provides limited assistance to the contractor administered by this Section of the technical specification in its commissioning/verification work.
1. The General Contractor of this project shall directly hire the Control System Integrator in a contract separate from the contract procuring the controls contractor administered by this Section of the technical specifications.
 2. The contractor administered by this Section of the technical specifications shall coordinate all work with the Control System Integrator. The contractor administered by this Section of the technical specifications shall integrate the ASHRAE Standard 135, BACnet/IP control network(s) with the Control System Integrator's area control through an Ethernet connection provided by the Control System Integrator.
 3. The contractor administered by this Section of the technical specifications shall provide a peer-to-peer networked, stand-alone, distributed control system. This direct digital control (DDC) system shall include one portable operator terminal - laptop, one digital display unit, microprocessor-based controllers, instrumentation, end control devices, wiring, piping, software, and related systems. This contractor is responsible for all device mounting and wiring.

4. Responsibility Table:

Item/Task	Section 23 09 23 contractor	Control system integrator	VA
ECC expansion		X	
ECC programming		X	
Devices, controllers, control panels and equipment	X		
Point addressing: all hardware and software points including setpoint, calculated point, data point(analog/binary), and reset schedule point	X		
Point mapping		X	
Network Programming	X		
ECC Graphics		X	
Controller programming and sequences	X		
Integrity of LAN communications	X		
Electrical wiring	X		
Operator system training		X	
LAN connections to devices	X		
LAN connections to ECC		X	
IP addresses			X
Overall system verification		X	
Controller and LAN system verification	X		

G. The direct-digital control system shall start and stop equipment, move (position) damper actuators and valve actuators, and vary speed of equipment to execute the mission of the control system. Use electricity as the motive force for all damper and valve actuators, unless use of pneumatics as motive force is specifically granted by the VAMC.

1.2 RELATED WORK

- A. Section 11 41 21, Walk-In Coolers and Freezers.
- B. Section 21 05 11, Common Work Results for Fire Suppression.
- C. Section 21 10 00, Water-Based Fire-Suppression Systems.
- D. Section 23 21 13, Hydronic Piping.
- E. Section 23 22 13, Steam and Condensate Heating Piping.
- F. Section 23 31 00, HVAC Ducts and Casings.
- G. Section 23 36 00, Air Terminal Units.
- H. Section 23 38 13, Commercial-Kitchen Hoods.
- I. Section 23 73 00, Indoor Central-Station Air-Handling Units.
- J. Section 23 74 13, Packaged, Outdoor, Central-Station Air-Handling Units.
- K. Section 26 05 11, Requirements for Electrical Installations.

- L. Section 26 05 21, Low-Voltage Electrical Power Conductors and Cables (600 Volts and Below).
- M. Section 26 05 26, Grounding and Bonding for Electrical Systems.
- N. Section 26 05 33, Raceway and Boxes for Electrical Systems.
- O. Section 26 09 23, Lighting Controls.
- P. Section 26 22 21, Specialty Transformers.
- Q. Section 26 27 26, Wiring Devices.
- R. Section 26 29 11, Motor Starters.
- S. Section 27 15 00, Communications Horizontal Cabling
- T. Section 28 31 00, Fire Detection and Alarm.

1.3 DEFINITION

- A. Algorithm: A logical procedure for solving a recurrent mathematical problem; A prescribed set of well-defined rules or processes for the solution of a problem in a finite number of steps.
- B. ARCNET: ANSI/ATA 878.1 - Attached Resource Computer Network. ARCNET is a deterministic LAN technology; meaning it's possible to determine the maximum delay before a device is able to transmit a message.
- C. Analog: A continuously varying signal value (e.g., temperature, current, velocity etc.
- D. BACnet: A Data Communication Protocol for Building Automation and Control Networks , ANSI/ASHRAE Standard 135. This communications protocol allows diverse building automation devices to communicate data over and services over a network.
- E. BACnet/IP: Annex J of Standard 135. It defines and allows for using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP sub-networks that share the same BACnet network number.
- F. BACnet Internetwork: Two or more BACnet networks connected with routers. The two networks may sue different LAN technologies.
- G. BACnet Network: One or more BACnet segments that have the same network address and are interconnected by bridges at the physical and data link layers.
- H. BACnet Segment: One or more physical segments of BACnet devices on a BACnet network, connected at the physical layer by repeaters.
- I. BACnet Broadcast Management Device (BBMD): A communications device which broadcasts BACnet messages to all BACnet/IP devices and other BBMDs connected to the same BACnet/IP network.

- J. BACnet Interoperability Building Blocks (BIBBs): BACnet Interoperability Building Blocks (BIBBs) are collections of one or more BACnet services. These are prescribed in terms of an "A" and a "B" device. Both of these devices are nodes on a BACnet internetwork.
- K. BACnet Testing Laboratories (BTL). The organization responsible for testing products for compliance with the BACnet standard, operated under the direction of BACnet International.
- L. Baud: It is a signal change in a communication link. One signal change can represent one or more bits of information depending on type of transmission scheme. Simple peripheral communication is normally one bit per Baud. (e.g., Baud rate = 78,000 Baud/sec is 78,000 bits/sec, if one signal change = 1 bit).
- M. Binary: A two-state system where a high signal level represents an "ON" condition and an "OFF" condition is represented by a low signal level.
- N. BMP or bmp: Suffix, computerized image file, used after the period in a DOS-based computer file to show that the file is an image stored as a series of pixels.
- O. Bus Topology: A network topology that physically interconnects workstations and network devices in parallel on a network segment.
- P. Control Unit (CU): Generic term for any controlling unit, stand-alone, microprocessor based, digital controller residing on secondary LAN or Primary LAN, used for local controls or global controls
- Q. Deadband: A temperature range over which no heating or cooling is supplied, i.e., 22-25 degrees C (72-78 degrees F), as opposed to a single point change over or overlap).
- R. Device: a control system component that contains a BACnet Device Object and uses BACnet to communicate with other devices.
- S. Device Object: Every BACnet device requires one Device Object, whose properties represent the network visible properties of that device. Every Device Object requires a unique Object Identifier number on the BACnet internetwork. This number is often referred to as the device instance.
- T. Device Profile: A specific group of services describing BACnet capabilities of a device, as defined in ASHRAE Standard 135-2008, Annex L. Standard device profiles include BACnet Operator Workstations (B-OWS), BACnet Building Controllers (B-BC), BACnet Advanced Application

Controllers (B-AAC), BACnet Application Specific Controllers (B-ASC), BACnet Smart Actuator (B-SA), and BACnet Smart Sensor (B-SS). Each device used in new construction is required to have a PICS statement listing which service and BIBBs are supported by the device.

- U. Diagnostic Program: A software test program, which is used to detect and report system or peripheral malfunctions and failures. Generally, this system is performed at the initial startup of the system.
- V. Direct Digital Control (DDC): Microprocessor based control including Analog/Digital conversion and program logic. A control loop or subsystem in which digital and analog information is received and processed by a microprocessor, and digital control signals are generated based on control algorithms and transmitted to field devices in order to achieve a set of predefined conditions.
- W. Distributed Control System: A system in which the processing of system data is decentralized and control decisions can and are made at the subsystem level. System operational programs and information are provided to the remote subsystems and status is reported back to the Engineering Control Center. Upon the loss of communication with the Engineering Control center, the subsystems shall be capable of operating in a stand-alone mode using the last best available data.
- X. Download: The electronic transfer of programs and data files from a central computer or operation workstation with secondary memory devices to remote computers in a network (distributed) system.
- Y. DXF: An AutoCAD 2-D graphics file format. Many CAD systems import and export the DXF format for graphics interchange.
- Z. Electrical Control: A control circuit that operates on line or low voltage and uses a mechanical means, such as a temperature sensitive bimetal or bellows, to perform control functions, such as actuating a switch or positioning a potentiometer.
- AA. Electronic Control: A control circuit that operates on low voltage and uses a solid-state components to amplify input signals and perform control functions, such as operating a relay or providing an output signal to position an actuator.
- BB. Engineering Control Center (ECC): The centralized control point for the intelligent control network. The ECC comprises of personal computer and connected devices to form a single workstation.

- CC. Ethernet: A trademark for a system for exchanging messages between computers on a local area network using coaxial, fiber optic, or twisted-pair cables.
- DD. Firmware: Firmware is software programmed into read only memory (ROM) chips. Software may not be changed without physically altering the chip.
- EE. Gateway: Communication hardware connecting two or more different protocols. It translates one protocol into equivalent concepts for the other protocol. In BACnet applications, a gateway has BACnet on one side and non-BACnet (usually proprietary) protocols on the other side.
- FF. GIF: Abbreviation of Graphic interchange format.
- GG. Graphic Program (GP): Program used to produce images of air handler systems, fans, chillers, pumps, and building spaces. These images can be animated and/or color-coded to indicate operation of the equipment.
- HH. Graphic Sequence of Operation: It is a graphical representation of the sequence of operation, showing all inputs and output logical blocks.
- II. I/O Unit: The section of a digital control system through which information is received and transmitted. I/O refers to analog input (AI, digital input (DI), analog output (AO) and digital output (DO). Analog signals are continuous and represent temperature, pressure, flow rate etc, whereas digital signals convert electronic signals to digital pulses (values), represent motor status, filter status, on-off equipment etc.
- JJ. I/P: a method for conveying and routing packets of information over LAN paths. User Datagram Protocol (UDP) conveys information to "sockets" without confirmation of receipt. Transmission Control Protocol (TCP) establishes "sessions", which have end-to-end confirmation and guaranteed sequence of delivery.
- KK. JPEG: A standardized image compression mechanism stands for Joint Photographic Experts Group, the original name of the committee that wrote the standard.
- LL. Local Area Network (LAN): A communication bus that interconnects operator workstation and digital controllers for peer-to-peer communications, sharing resources and exchanging information.
- MM. Network Repeater: A device that receives data packet from one network and rebroadcasts to another network. No routing information is added to the protocol.

- NN. MS/TP: Master-slave/token-passing (ISO/IEC 8802, Part 3). It is not an acceptable LAN option for VAMC health-care facilities. It uses twisted-pair wiring for relatively low speed and low cost communication.
- OO. Native BACnet Device: A device that uses BACnet as its primary method of communication with other BACnet devices without intermediary gateways. A system that uses native BACnet devices at all levels is a native BACnet system.
- PP. Network Number: A site-specific number assigned to each network segment to identify for routing. This network number must be unique throughout the BACnet internetwork.
- QQ. Object: The concept of organizing BACnet information into standard components with various associated properties. Examples include analog input objects and binary output objects.
- RR. Object Identifier: An object property used to identify the object, including object type and instance. Object Identifiers must be unique within a device.
- SS. Object Properties: Attributes of an object. Examples include present value and high limit properties of an analog input object. Properties are defined in ASHRAE 135; some are optional and some are required. Objects are controlled by reading from and writing to object properties.
- TT. Operating system (OS): Software, which controls the execution of computer application programs.
- UU. PCX: File type for an image file. When photographs are scanned onto a personal computer they can be saved as PCX files and viewed or changed by a special application program as Photo Shop.
- VV. Peripheral: Different components that make the control system function as one unit. Peripherals include monitor, printer, and I/O unit.
- WW. Peer-to-Peer: A networking architecture that treats all network stations as equal partners- any device can initiate and respond to communication with other devices.
- XX. PICS: Protocol Implementation Conformance Statement, describing the BACnet capabilities of a device. All BACnet devices have published PICS.
- YY. PID: Proportional, integral, and derivative control, used to control modulating equipment to maintain a setpoint.

- ZZ. Repeater: A network component that connects two or more physical segments at the physical layer.
- AAA. Router: a component that joins together two or more networks using different LAN technologies. Examples include joining a BACnet Ethernet LAN to a BACnet MS/TP LAN.
- BBB. Sensors: devices measuring state points or flows, which are then transmitted back to the DDC system.
- CCC. Thermostats : devices measuring temperatures, which are used in control of standalone or unitary systems and equipment not attached to the DDC system.

1.4 QUALITY ASSURANCE

A. Criteria:

1. Single Source Responsibility of subcontractor: The Contractor shall obtain hardware and software supplied under this Section and delegate the responsibility to a single source controls installation subcontractor. The controls subcontractor shall be responsible for the complete design, installation, and commissioning of the system. The controls subcontractor shall be in the business of design, installation and service of such building automation control systems similar in size and complexity.
2. Controls subcontractor shall be Siemens Building Technologies.
Contact info: Mark Saven, 1-734-456-3927.
3. Equipment and Materials: Equipment and materials shall be cataloged products of manufacturers regularly engaged in production and installation of HVAC control systems. Products shall be manufacturer's latest standard design and have been tested and proven in actual use.
4. Provide a competent and experienced Project Manager employed by the Controls Contractor. The Project Manager shall be supported as necessary by other Contractor employees in order to provide professional engineering, technical and management service for the work. The Project Manager shall attend scheduled Project Meetings as required and shall be empowered to make technical, scheduling and related decisions on behalf of the Controls Contractor.

B. Codes and Standards:

1. All work shall conform to the applicable Codes and Standards.

2. Electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference, and be so labeled.

1.5 PERFORMANCE

- A. The system shall conform to the following:
 1. Graphic Display: The system shall display up to four (4) graphics on a single screen with a minimum of twenty (20) dynamic points per graphic. All current data shall be displayed within ten (10) seconds of the request.
 2. Graphic Refresh: The system shall update all dynamic points with current data within eight (8) seconds. Data refresh shall be automatic, without operator intervention.
 3. Object Command: The maximum time between the command of a binary object by the operator and the reaction by the device shall be two(2) seconds. Analog objects shall start to adjust within two (2) seconds.
 4. Object Scan: All changes of state and change of analog values shall be transmitted over the high-speed network such that any data used or displayed at a controller or work-station will be current, within the prior six (6) seconds.
 5. Alarm Response Time: The maximum time from when an object goes into alarm to when it is annunciated at the workstation shall not exceed (10) seconds.
 6. Program Execution Frequency: Custom and standard applications shall be capable of running as often as once every (5) seconds. The Contractor shall be responsible for selecting execution times consistent with the mechanical process under control.
 7. Multiple Alarm Annunciations: All workstations on the network shall receive alarms within five (5) seconds of each other.
 8. Performance: Programmable Controllers shall be able to execute DDC PID control loops at a selectable frequency from at least once every one (1) second. The controller shall scan and update the process value and output generated by this calculation at this same frequency.
 9. Reporting Accuracy: Listed below are minimum acceptable reporting end-to-end accuracies for all values reported by the specified system:

Measured Variable	Reported Accuracy
Space temperature	$\pm 0.5^{\circ}\text{C}$ ($\pm 1^{\circ}\text{F}$)
Ducted air temperature	$\pm 0.5^{\circ}\text{C}$ [$\pm 1^{\circ}\text{F}$]
Outdoor air temperature	$\pm 1.0^{\circ}\text{C}$ [$\pm 2^{\circ}\text{F}$]
Dew Point	$\pm 1.5^{\circ}\text{C}$ [$\pm 3^{\circ}\text{F}$]
Water temperature	$\pm 0.5^{\circ}\text{C}$ [$\pm 1^{\circ}\text{F}$]
Relative humidity	$\pm 2\%$ RH
Water flow	$\pm 1\%$ of reading
Air flow (terminal)	$\pm 10\%$ of reading
Air flow (measuring stations)	$\pm 5\%$ of reading
Carbon Monoxide (CO)	$\pm 5\%$ of reading
Carbon Dioxide (CO ₂)	± 50 ppm
Air pressure (ducts)	± 25 Pa [± 0.1 "w.c.]
Air pressure (space)	± 0.3 Pa [± 0.001 "w.c.]
Water pressure	$\pm 2\%$ of full scale *Note 1
Electrical Power	$\pm 0.5\%$ of reading

Note 1: for both absolute and differential pressure

10. Control stability and accuracy: Control sequences shall maintain measured variable at setpoint within the following tolerances:

Controlled Variable	Control Accuracy	Range of Medium
Air Pressure	± 50 Pa (± 0.2 in. w.g.)	0-1.5 kPa (0-6 in. w.g.)
Air Pressure	± 3 Pa (± 0.01 in. w.g.)	-25 to 25 Pa (-0.1 to 0.1 in. w.g.)
Airflow	$\pm 10\%$ of full scale	
Space Temperature	$\pm 1.0^{\circ}\text{C}$ ($\pm 2.0^{\circ}\text{F}$)	
Duct Temperature	$\pm 1.5^{\circ}\text{C}$ ($\pm 3^{\circ}\text{F}$)	
Humidity	$\pm 5\%$ RH	
Fluid Pressure	± 10 kPa (± 1.5 psi)	0-1 MPa (1-150 psi)
Fluid Pressure	± 250 Pa (± 1.0 in. w.g.)	0-12.5 kPa (0-50 in. w.g.) differential

11. Extent of direct digital control: control design shall allow for at least the points indicated on the points lists on the drawings.

1.6 WARRANTY

- A. Labor and materials for control systems shall be warranted for a period as specified under Warranty in FAR clause 52.246-21.
- B. Control system failures during the warranty period shall be adjusted, repaired, or replaced at no cost or reduction in service to the owner. The system includes all computer equipment, transmission equipment, and all sensors and control devices.
- D. Controls and Instrumentation subcontractor shall be responsible for temporary operations and maintenance of the control systems during the construction period until final commissioning, training of facility operators and acceptance of the project by VAMC.

1.7 SUBMITTALS

- A. Submit shop drawings in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's literature and data for all components including the following:
 - 1. A wiring diagram for each type of input device and output device including DDC controllers, modems, repeaters, etc. Diagram shall show how the device is wired and powered, showing typical connections at the digital controllers and each power supply, as well as the device itself. Show for all field connected devices, including but not limited to, control relays, motor starters, electric or electronic actuators, and temperature pressure, flow and humidity sensors and transmitters.
 - 2. A diagram of each terminal strip, including digital controller terminal strips, terminal strip location, termination numbers and the associated point names.
 - 3. Control dampers and control valves schedule, including the size and pressure drop.
 - 5. Catalog cut sheets of all equipment used. This includes, but is not limited to software (by manufacturer and by third parties), DDC controllers, panels, peripherals, airflow measuring stations and associated components, and auxiliary control devices such as sensors, actuators, and control dampers. When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted.

Each submitted piece of literature and drawings should clearly reference the specification and/or drawings that it supposed to represent.

6. Sequence of operations for each HVAC system and the associated control diagrams. Equipment and control labels shall correspond to those shown on the drawings.
 7. Color prints of proposed graphics with a list of points for display.
 8. Furnish a BACnet Protocol Implementation Conformance Statement (PICS) for each BACnet-compliant device.
 9. Schematic wiring diagrams for all control, communication and power wiring. Provide a schematic drawing of the central system installation. Label all cables and ports with computer manufacturers' model numbers and functions. Show all interface wiring to the control system.
 10. An instrumentation list for each controlled system. Each element of the controlled system shall be listed in table format. The table shall show element name, type of device, manufacturer, model number, and product data sheet number.
 11. Riser diagrams of wiring between central control unit and all control panels.
 12. Scaled plan drawings showing routing of LAN and locations of control panels, controllers, routers, gateways, ECC, and larger controlled devices.
 13. Construction details for all installed conduit, cabling, raceway, cabinets, and similar. Construction details of all penetrations and their protection.
 14. Quantities of submitted items may be reviewed but are the responsibility of the contractor administered by this Section of the technical specifications.
- C. Product Certificates: Compliance with Article, QUALITY ASSURANCE.
- D. Licenses: Provide licenses for all software residing on and used by the Controls Systems and transfer these licenses to the Owner prior to completion.
- E. As Built Control Drawings:
1. Furnish three (3) copies of as-built drawings for each control system. The documents shall be submitted for approval prior to final completion.

2. Furnish one (1) stick set of applicable control system prints for each mechanical system for wall mounting. The documents shall be submitted for approval prior to final completion.
3. Furnish one (1) CD-ROM in CAD DWG and/or .DXF format for the drawings noted in subparagraphs above.

F. Operation and Maintenance (O/M) Manuals):

1. Submit in accordance with Article, INSTRUCTIONS, in Specification Section 01 00 00, GENERAL REQUIREMENTS.
2. Include the following documentation:
 - a. General description and specifications for all components, including logging on/off, alarm handling, producing trend reports, overriding computer control, and changing setpoints and other variables.
 - b. Detailed illustrations of all the control systems specified for ease of maintenance and repair/replacement procedures, and complete calibration procedures.
 - c. One copy of the final version of all software provided including operating systems, programming language, operator workstation software, and graphics software.
 - d. Complete troubleshooting procedures and guidelines for all systems.
 - e. Complete operating instructions for all systems.
 - f. Recommended preventive maintenance procedures for all system components including a schedule of tasks for inspection, cleaning and calibration. Provide a list of recommended spare parts needed to minimize downtime.
 - g. Training Manuals: Submit the course outline and training material to the Owner for approval three (3) weeks prior to the training to VAMC facility personnel. These persons will be responsible for maintaining and the operation of the control systems, including programming. The Owner reserves the right to modify any or all of the course outline and training material.
 - h. Licenses, guaranty, and other pertaining documents for all equipment and systems.

G. Submit Performance Report to Contracting Officer Technical Representative prior to final inspection.

1.8 PROJECT CONDITIONS (ENVIRONMENTAL CONDITIONS OF OPERATION)

- A. The ECC and peripheral devices and system support equipment shall be designed to operate in ambient condition of 20 to 35°C (65 to 90°F) at a relative humidity of 20 to 80% non-condensing.
- B. The CUs used outdoors shall be mounted in NEMA 4 waterproof enclosures, and shall be rated for operation at -40 to 65°C (-40 to 150°F).
- C. All electronic equipment shall operate properly with power fluctuations of plus 10 percent to minus 15 percent of nominal supply voltage.
- D. Sensors and controlling devices shall be designed to operate in the environment, which they are sensing or controlling.

1.9 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):
Standard 135-08.....BACNET Building Automation and Control Networks
- C. American Society of Mechanical Engineers (ASME):
B16.18-05.....Cast Copper Alloy Solder Joint Pressure Fittings.
B16.22-05.....Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- D. American Society of Testing Materials (ASTM):
B32-04.....Standard Specification for Solder Metal
B88-03.....Standard Specifications for Seamless Copper Water Tube
B88M-05.....Standard Specification for Seamless Copper Water Tube (Metric)
B280-03.....Standard Specification for Seamless Copper Tube for Air-Conditioning and Refrigeration Field Service
D2737-03.....Standard Specification for Polyethylene (PE) Plastic Tubing
- E. Federal Communication Commission (FCC):
Rules and Regulations Title 47 Chapter 1-2001 Part 15: Radio Frequency Devices.

F. Institute of Electrical and Electronic Engineers (IEEE):

802.3-05.....Information Technology-Telecommunications and
Information Exchange between Systems-Local and
Metropolitan Area Networks- Specific
Requirements-Part 3: Carrier Sense Multiple
Access with Collision Detection (CSMA/CD)
Access method and Physical Layer Specifications

G. National Fire Protection Association (NFPA):

70-08.....National Electric Code
90A-09.....Standard for Installation of Air-Conditioning
and Ventilation Systems

H. Underwriter Laboratories Inc (UL):

94-06.....Tests for Flammability of Plastic Materials for
Parts and Devices and Appliances
294-05.....Access Control System Units
486A/486B-04-.....Wire Connectors
555S-06.....Standard for Smoke Dampers
916-07.....Energy Management Equipment
1076-05.....Proprietary Burglar Alarm Units and Systems

PART 2 - PRODUCTS

2.1 MATERIALS

Use new products that the manufacturer is currently manufacturing and that have been installed in a minimum of (5) installations performed within the past (2) years. Spare parts shall be available for at least five years after completion of this contract.

2.2 CONTROLS SYSTEM ARCHITECTURE

A. General

1. The Controls Systems is existing and shall be modified as required to meet the scope of the current project.

B. The Specifications for the individual elements and component subsystems shall be minimum requirements and shall be augmented as necessary by the Contractor to achieve both compliance with all applicable codes, standards and to meet all requirements of the Contract Documents.

C. Network Architecture

1. The Controls Systems Application network is an existing proprietary Siemens system. New work shall be fully integrated into the existing system, using fully compatible components.
2. The networks shall utilize only copper and optical fiber communication media as appropriate and shall comply with applicable codes, ordinances and regulations.

D. Third Party Interfaces:

1. The contractor administered by this Section of the technical specifications shall include necessary hardware, equipment, software and programming to allow data communications between the controls systems and building systems supplied by other trades.
2. Other manufacturers and contractors supplying other associated systems and equipment shall provide their necessary hardware, software and start-up at their cost and shall cooperate fully with the contractor administered by this Section of the technical specifications in a timely manner and at their cost to ensure complete functional integration.

2.3 COMMUNICATION

- A. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internetwork. Controller and operator interface communication shall conform to ANSI/ASHRAE Standard 135-2008, BACnet.
 1. The Data link / physical layer protocol (for communication) acceptable to the VAMC throughout its facilities is Ethernet (ISO 8802-3) and BACnet/IP.
- B. Each controller shall have a communication port for connection to an operator interface.
- C. Project drawings indicate remote buildings or sites to be connected by a nominal 56,000 baud modem over voice-grade telephone lines. In each remote location a modem and field device connection shall allow communication with each controller on the internetwork as specified in Paragraph D.
- D. Internetwork operator interface and value passing shall be transparent to internetwork architecture.
 1. An operator interface connected to a controller shall allow the operator to interface with each internetwork controller as if directly connected. Controller information such as data, status,

reports, system software, and custom programs shall be viewable and editable from each internetwork controller.

2. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. Program and test all cross-controller links required to execute specified control system operation. An authorized operator shall be able to edit cross-controller links by typing a standard object address.
- E. System shall be expandable to at least twice the required input and output objects with additional controllers, associated devices, and wiring. Expansion shall not require operator interface hardware additions or software revisions.
- F. ECCs and Controllers with real-time clocks shall use the BACnet Time Synchronization service. The system shall automatically synchronize system clocks daily from an operator-designated device via the internetwork. The system shall automatically adjust for daylight savings and standard time as applicable.

2.4 NETWORK AND DEVICE NAMING CONVENTION

A. Network Numbers

1. BACnet network numbers shall be based on a "facility code, network" concept. The "facility code" is the VAMC's or VAMC campus' assigned numeric value assigned to a specific facility or building. The "network" typically corresponds to a "floor" or other logical configuration within the building. BACnet allows 65535 network numbers per BACnet internet work.
2. The network numbers are thus formed as follows: "Net #" = "FFFNN" where:
 - a. FFF = Facility code (see below)
 - b. NN = 00-99 This allows up to 100 networks per facility or building

B. Device Instances

1. BACnet allows 4194305 unique devices instances per BACnet internet work. Using Agency's unique device instances are formed as follows: "Dev #" = "FFFNNDD" where
 - a. FFF and N are as above and
 - b. DD = 00-99, this allows up to 100 devices per network.

2. Note Special cases, where the network architecture of limiting device numbering to DD causes excessive subnet works. The device number can be expanded to DDD and the network number N can become a single digit. In NO case shall the network number N and the device number D exceed 4 digits.
3. Facility code assignments:
4. 000-400 Building/facility number
5. Note that some facilities have a facility code with an alphabetic suffix to denote wings, related structures, etc. The suffix will be ignored. Network numbers for facility codes above 400 will be assigned in the range 000-399.

C. Device Names

1. Name the control devices based on facility name, location within a facility, the system or systems that the device monitors and/or controls, or the area served. The intent of the device naming is to be easily recognized. Names can be up to 254 characters in length, without embedded spaces. Provide the shortest descriptive, but unambiguous, name. For example, in building #123 prefix the number with a "B" followed by the building number, if there is only one chilled water pump "CHWP-1", a valid name would be "B123.CHWP.1.STARTSTOP". If there are two pumps designated "CHWP-1", one in a basement mechanical room (Room 0001) and one in a penthouse mechanical room (Room PH01), the names could be "B123.R0001.CHWP.1.STARTSTOP " or " B123.RPH01.CHWP.1.STARTSTOP". In the case of unitary controllers, for example a VAV box controller, a name might be "B123.R101.VAV". These names should be used for the value of the "Object_Name" property of the BACnet Device objects of the controllers involved so that the BACnet name and the EMCS name are the same.

2.5 BACNET DEVICES

- A. All BACnet Devices - controllers, gateways, routers, actuators and sensors shall conform to BACnet Device Profiles and shall be BACnet Testing Laboratories (BTL) -Listed as conforming to those Device Profiles. Protocol Implementation Conformance Statements (PICSSs), describing the BACnet capabilities of the Devices shall be published and available of the Devices through links in the BTL website.

1. BACnet Building Controllers, historically referred to as NACs, shall conform to the BACnet B-BC Device Profile, and shall be BTL-Listed as conforming to the B-BC Device Profile. The Device's PICS shall be submitted.
2. BACnet Advanced Application Controllers shall conform to the BACnet B-AAC Device Profile, and shall be BTL-Listed as conforming to the B-AAC Device Profile. The Device's PICS shall be submitted.
3. BACnet Application Specific Controllers shall conform to the BACnet B-ASC Device Profile, and shall be BTL-Listed as conforming to the B-ASC Device Profile. The Device's PICS shall be submitted.
4. BACnet Smart Actuators shall conform to the BACnet B-SA Device Profile, and shall be BTL-Listed as conforming to the B-SA Device Profile. The Device's PICS shall be submitted.
5. BACnet Smart Sensors shall conform to the BACnet B-SS Device Profile, and shall be BTL-Listed as conforming to the B-SS Device Profile. The Device's PICS shall be submitted.
6. BACnet routers and gateways shall conform to the BACnet B-OTH Device Profile, and shall be BTL-Listed as conforming to the B-OTH Device Profile. The Device's PICS shall be submitted.

2.6 CONTROLLERS

- A. General. Provide an adequate number of BTL-Listed B-BC building controllers and an adequate number of BTL-Listed B-AAC advanced application controllers to achieve the performance specified in the Part 1 Article on "System Performance." Each of these controllers shall meet the following requirements.
 1. The controller shall have sufficient memory to support its operating system, database, and programming requirements.
 2. The building controller shall share data with the ECC and the other networked building controllers. The advanced application controller shall share data with its building controller and the other networked advanced application controllers.
 3. The operating system of the controller shall manage the input and output communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
 4. Controllers that perform scheduling shall have a real-time clock.

5. The controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall:
 - a. assume a predetermined failure mode, and
 - b. generate an alarm notification.
 6. The controller shall communicate with other BACnet devices on the internetwork using the BACnet Read (Execute and Initiate) and Write (Execute and Initiate) Property services.
 7. Communication.
 - a. Each controller shall reside on a BACnet network using the ISO 8802-3 (Ethernet) Data Link/Physical layer protocol for its communications. Each building controller also shall perform BACnet routing if connected to a network of custom application and application specific controllers.
 - b. The controller shall provide a service communication port using BACnet Data Link/Physical layer protocol for connection to a portable operator's terminal.
 8. Keypad. A local keypad and display shall be provided for each controller. The keypad shall be provided for interrogating and editing data. Provide a system security password shall be available to prevent unauthorized use of the keypad and display.
 9. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
 10. Memory. The controller shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.
 11. The controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Controller operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).
- B. Provide BTL-Listed B-ASC application specific controllers for each piece of equipment for which they are constructed. Application specific controllers shall communicate with other BACnet devices on the internetwork using the BACnet Read (Execute) Property service.

1. Each B-ASC shall be capable of stand-alone operation and shall continue to provide control functions without being connected to the network.
2. Each B-ASC will contain sufficient I/O capacity to control the target system.
3. Communication.
 - a. Each controller shall reside on a BACnet network using the ISO 8802-3 (Ethernet) Data Link/Physical layer protocol for its communications. Each building controller also shall perform BACnet routing if connected to a network of custom application and application specific controllers.
 - b. Each controller shall have a BACnet Data Link/Physical layer compatible connection for a laptop computer or a portable operator's tool. This connection shall be extended to a space temperature sensor port where shown.
4. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
5. Memory. The application specific controller shall use nonvolatile memory and maintain all BIOS and programming information in the event of a power loss.
6. Immunity to power and noise. Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80%. Operation shall be protected against electrical noise of 5-120 Hz and from keyed radios up to 5 W at 1 m (3 ft).
7. Transformer. Power supply for the ASC must be rated at a minimum of 125% of ASC power consumption and shall be of the fused or current limiting type.

C. Direct Digital Controller Software

1. The software programs specified in this section shall be commercially available, concurrent, multi-tasking operating system and support the use of software application that operates under DOS or Microsoft Windows.
2. All points shall be identified by up to 30-character point name and 16-character point descriptor. The same names shall be used at the ECC.

3. All control functions shall execute within the stand-alone control units via DDC algorithms. The VAMC shall be able to customize control strategies and sequences of operations defining the appropriate control loop algorithms and choosing the optimum loop parameters.
4. All controllers shall be capable of being programmed to utilize stored default values for assured fail-safe operation of critical processes. Default values shall be invoked upon sensor failure or, if the primary value is normally provided by the central or another CU, or by loss of bus communication. Individual application software packages shall be structured to assume a fail-safe condition upon loss of input sensors. Loss of an input sensor shall result in output of a sensor-failed message at the ECC. Each ACU and RCU shall have capability for local readouts of all functions. The UCUs shall be read remotely.
5. All DDC control loops shall be able to utilize any of the following control modes:
 - a. Two position (on-off, slow-fast) control.
 - b. Proportional control.
 - c. Proportional plus integral (PI) control.
 - d. Proportional plus integral plus derivative (PID) control. All PID programs shall automatically invoke integral wind up prevention routines whenever the controlled unit is off, under manual control of an automation system or time initiated program.
 - e. Automatic tuning of control loops.
6. System Security: Operator access shall be secured using individual password and operator's name. Passwords shall restrict the operator to the level of object, applications, and system functions assigned to him. A minimum of six (6) levels of security for operator access shall be provided.
7. Application Software: The controllers shall provide the following programs as a minimum for the purpose of optimizing energy consumption while maintaining comfortable environment for occupants. All application software shall reside and run in the system digital controllers. Editing of the application shall occur at the ECC or via a portable operator's terminal, when it is necessary, to access directly the programmable unit.

- a. Economizer: An economizer program shall be provided for VAV systems. This program shall control the position of air handler relief, return, and outdoors dampers. If the outdoor air dry bulb temperature and humidity fall below changeover setpoint the energy control center will modulate the dampers to provide 100 percent outdoor air. The operator shall be able to override the economizer cycle and return to minimum outdoor air operation at any time.
- b. Night Setback/Morning Warm up Control: The system shall provide the ability to automatically adjust setpoints for this mode of operation.
- c. Optimum Start/Stop (OSS): Optimum start/stop program shall automatically be coordinated with event scheduling. The OSS program shall start HVAC equipment at the latest possible time that will allow the equipment to achieve the desired zone condition by the time of occupancy, and it shall also shut down HVAC equipment at the earliest possible time before the end of the occupancy period and still maintain desired comfort conditions. The OSS program shall consider both outside weather conditions and inside zone conditions. The program shall automatically assign longer lead times for weekend and holiday shutdowns. The program shall poll all zones served by the associated AHU and shall select the warmest and coolest zones. These shall be used in the start time calculation. It shall be possible to assign occupancy start times on a per air handler unit basis. The program shall meet the local code requirements for minimum outdoor air while the building is occupied. Modification of assigned occupancy start/stop times shall be possible via the ECC.
- d. Event Scheduling: Provide a comprehensive menu driven program to automatically start and stop designated points or a group of points according to a stored time. This program shall provide the capability to individually command a point or group of points. When points are assigned to one common load group it shall be possible to assign variable time advances/delays between each successive start or stop within that group. Scheduling shall be

calendar based and advance schedules may be defined up to one year in advance. Advance schedule shall override the day-to-day schedule. The operator shall be able to define the following information:

- 1) Time, day.
 - 2) Commands such as on, off, auto.
 - 3) Time delays between successive commands.
 - 4) Manual overriding of each schedule.
 - 5) Allow operator intervention.
- f. Alarm Reporting: The operator shall be able to determine the action to be taken in the event of an alarm. Alarms shall be routed to the ECC based on time and events. An alarm shall be able to start programs, login the event, print and display the messages. The system shall allow the operator to prioritize the alarms to minimize nuisance reporting and to speed operator's response to critical alarms. A minimum of six (6) priority levels of alarms shall be provided for each point.
- g. Remote Communications: The system shall have the ability to dial out in the event of an alarm to the ECC and alpha-numeric pagers. The alarm message shall include the name of the calling location, the device that generated the alarm, and the alarm message itself. The operator shall be able to remotely access and operate the system using dial up communications. Remote access shall allow the operator to function the same as local access.
- h. Maintenance Management (PM): The program shall monitor equipment status and generate maintenance messages based upon the operators defined equipment run time, starts, and/or calendar date limits. A preventative maintenance alarm shall be printed indicating maintenance requirements based on pre-defined run time. Each preventive message shall include point description, limit criteria and preventative maintenance instruction assigned to that limit. A minimum of 480-character PM shall be provided for each component of units such as air handling units.

2.7 SENSORS (AIR, WATER AND STEAM)

- A. Sensors' measurements shall be read back to the DDC system, and shall be visible by the ECC.

- B. Temperature and Humidity Sensors shall be electronic, vibration and corrosion resistant for wall, immersion, and/or duct mounting. Provide all remote sensors as required for the systems.
1. Temperature Sensors: thermistor type for terminal units and Resistance Temperature Device (RTD) with an integral transmitter type for all other sensors.
 - a. Duct sensors shall be rigid or averaging type as shown on drawings. Averaging sensor shall be a minimum of 1 linear ft of sensing element for each sq ft of cooling coil face area.
 - b. Immersion sensors shall be provided with a separable well made of stainless steel, bronze or monel material. Pressure rating of well is to be consistent with the system pressure in which it is to be installed.
 - c. Space sensors shall be equipped with in-space User set-point adjustment, override switch, numerical temperature display on sensor cover, and communication port. Match room thermostats. Provide a tooled-access cover.
 - 1) Public space sensor: setpoint adjustment shall be only through the ECC or through the DDC system's diagnostic device/laptop. Do not provide in-space User set-point adjustment. Provide an opaque keyed-entry cover if needed to restrict in-space User set-point adjustment.
 - 2) Psychiatric patient room sensor: sensor shall be flush with wall, shall not include an override switch, numerical temperature display on sensor cover, shall not include a communication port and shall not allow in-space User set-point adjustment. Setpoint adjustment shall be only through the ECC or through the DDC system's diagnostic device/laptop. Provide a stainless steel coverplate with an insulated back and security screws.
 - d. Outdoor air temperature sensors shall have watertight inlet fittings and be shielded from direct sunlight.
 - f. Wire: Twisted, shielded-pair cable.
 - g. Output Signal: 4-20 ma.
 2. Humidity Sensors: Bulk polymer sensing element type.
 - a. Duct and room sensors shall have a sensing range of 20 to 80 percent with accuracy of ± 2 to ± 5 percent RH, including hysteresis, linearity, and repeatability.

- b. Outdoor humidity sensors shall be furnished with element guard and mounting plate and have a sensing range of 0 to 100 percent RH.
 - c. 4-20 ma continuous output signal.
- C. Static Pressure Sensors: Non-directional, temperature compensated.
 - 1. 4-20 ma output signal.
 - 2. 0 to 5 inches wg for duct static pressure range.
 - 3. 0 to 0.25 inch wg for Building static pressure range.
- D. Flow switches:
 - 1. Shall be either paddle or differential pressure type.
 - a. Paddle-type switches (liquid service only) shall be UL Listed, SPDT snap-acting, adjustable sensitivity with NEMA 4 enclosure.
 - b. Differential pressure type switches (air or water service) shall be UL listed, SPDT snap acting, NEMA 4 enclosure, with scale range and differential suitable for specified application.
- E. Current Switches: Current operated switches shall be self powered, solid state with adjustable trip current as well as status, power, and relay command status LED indication. The switches shall be selected to match the current of the application and output requirements of the DDC systems.

2.8 CONTROL CABLES

- A. General:
 - 1. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments. Comply with Sections 27 05 26 and 26 05 26.
 - 2. Cable conductors to provide protection against induction in circuits. Crosstalk attenuation within the System shall be in excess of -80 dB throughout the frequency ranges specified.
 - 3. Minimize the radiation of RF noise generated by the System equipment so as not to interfere with any audio, video, data, computer main distribution frame (MDF), telephone customer service unit (CSU), and electronic private branch exchange (EPBX) equipment the System may service.
 - 4. The as-installed drawings shall identify each cable as labeled, used cable, and bad cable pairs.

5. Label system's cables on each end. Test and certify cables in writing to the VAMC before conducting proof-of-performance testing. Minimum cable test requirements are for impedance compliance, inductance, capacitance, signal level compliance, opens, shorts, cross talk, noise, and distortion, and split pairs on all cables in the frequency ranges used. Make available all cable installation and test records at demonstration to the VAMC. All changes (used pair, failed pair, etc.) shall be posted in these records as the change occurs.
6. Power wiring shall not be run in conduit with communications trunk wiring or signal or control wiring operating at 100 volts or less.
- B. Analogue control cabling shall be not less than No. 18 AWG solid, with thermoplastic insulated conductors as specified in Section 26 05 21.
- C. Copper digital communication cable between the ECC and the B-BC and B-AAC controllers shall be 100BASE-TX Ethernet, Category 5e or 6, not less than minimum 24 American Wire Gauge (AWG) solid, Shielded Twisted Pair (STP) or Unshielded Twisted Pair (UTP), with thermoplastic insulated conductors, enclosed in a thermoplastic outer jacket, as specified in Section 27 15 00.
1. Other types of media commonly used within IEEE Std 802.3 LANs (e.g., 10Base-T and 10Base-2) shall be used only in cases to interconnect with existing media.
- D. Optical digital communication fiber, if used, shall be Multimode or Singlemode fiber, 62.5/125 micron for multimode or 10/125 micron for singlemode micron with SC or ST connectors as specified in TIA-568-C.1. Terminations, patch panels, and other hardware shall be compatible with the specified fiber and shall be as specified in Section 27 15 00. Fiber-optic cable shall be suitable for use with the 100Base-FX or the 100Base-SX standard (as applicable) as defined in IEEE Std 802.3.

2.9 THERMOSTATS AND HUMIDISTATS

- A. Room thermostats controlling unitary standalone heating and cooling devices not connected to the DDC system shall have three modes of operation (heating - null or dead band - cooling). Wall mounted thermostats shall have manufacturer's standard finish, setpoint range and temperature display and external adjustment:

1. Electronic Thermostats: Solid-state, microprocessor based, programmable to daily, weekend, and holiday schedules.
 - a. Public Space Thermostat: Public space thermostat shall have a thermistor sensor and shall not have a visible means of setpoint adjustment. Adjustment shall be via the digital controller to which it is connected.
 - b. Patient Room Thermostats: thermistor with in-space User setpoint adjustment and an on-casing room temperature numerical temperature display.
 - c. Psychiatric Patient Room Sensors: Electronic duct sensor as noted under Article 2.4.
 - d. Battery replacement without program loss.
- B. Strap-on thermostats shall be enclosed in a dirt-and-moisture proof housing with fixed temperature switching point and single pole, double throw switch.
- C. Freezestats shall have a minimum of 300 mm (one linear foot) of sensing element for each 0.093 square meter (one square foot) of coil area. A freezing condition at any increment of 300 mm (one foot) anywhere along the sensing element shall be sufficient to operate the thermostatic element. Freezestats shall be manually-reset.
- D. Room Humidistats: Provide fully proportioning humidistat with adjustable throttling range for accuracy of settings and conservation. The humidistat shall have setpoint scales shown in percent of relative humidity located on the instrument. Systems showing moist/dry or high/low are not acceptable.

2.10 FINAL CONTROL ELEMENTS AND OPERATORS

- A. Fail Safe Operation: Control valves and dampers shall provide "fail safe" operation in either the normally open or normally closed position as required for freeze, moisture, and smoke or fire protection.
- B. Spring Ranges: Range as required for system sequencing and to provide tight shut-off.
- C. Power Operated Control Dampers (other than VAV Boxes): Factory fabricated, balanced type dampers. All modulating dampers shall be opposed blade type and gasketed. Blades for two-position, duct-mounted dampers shall be parallel, airfoil (streamlined) type for minimum noise generation and pressure drop.

1. Leakage: Maximum leakage in closed position shall not exceed 7 L/S (15 CFMs) differential pressure for outside air and exhaust dampers and 200 L/S/ square meter (40 CFM/sq. ft.) at 50 mm (2 inches) differential pressure for other dampers.
2. Frame shall be galvanized steel channel with seals as required to meet leakage criteria.
3. Blades shall be galvanized steel or aluminum, 200 mm (8 inch) maximum width, with edges sealed as required.
4. Bearing shall be nylon, bronze sleeve or ball type.
5. Hardware shall be zinc-plated steel. Connected rods and linkage shall be non-slip. Working parts of joints shall be brass, bronze, nylon or stainless steel.

D. Control Valves:

1. Valves shall be rated for a minimum of 150 percent of system operating pressure at the valve location but not less than 900 kPa (125 psig).
2. Valves 50 mm (2 inches) and smaller shall be bronze body with threaded or flare connections.
3. Valves 60 mm (2 1/2 inches) and larger shall be bronze or iron body with flanged connections.
4. Brass or bronze seats except for valves controlling media above 100 degrees C (210 degrees F), which shall have stainless steel seats.
5. Flow characteristics:
 - a. Three way modulating valves shall be globe pattern. Position versus flow relation shall be linear relation for steam or equal percentage for water flow control.
 - b. Two-way modulating valves shall be globe pattern. Position versus flow relation shall be linear for steam and equal percentage for water flow control.
 - c. Two-way 2-position valves shall be ball, gate or butterfly type.
6. Maximum pressure drop:
 - a. Two position steam control: 20 percent of inlet gauge pressure.
 - b. Modulating Steam Control: 80 percent of inlet gauge pressure (acoustic velocity limitation).
 - c. Modulating water flow control, greater of 3 meters (10 feet) of water or the pressure drop through the apparatus.
7. Two position water valves shall be line size.

E. Damper and Valve Operators and Relays:

1. Electronic damper operators: Metal parts shall be aluminum, mill finish galvanized steel, or zinc plated steel or stainless steel. Provide actuator heads which allow for electrical conduit attachment. The motors shall have sufficient closure torque to allow for complete closure of valve or damper under pressure. Provide multiple motors as required to achieve sufficient closeoff torque.
 - a. VAV Box actuator shall be mounted on the damper axle or shall be of the air valve design, and shall provide complete modulating control of the damper. The motor shall have a closure torque of 35-inch pounds minimum with full torque applied at close off to attain minimum leakage.
2. See drawings for required control operation.

2.11 AIR FLOW CONTROL

- A. Airflow and static pressure shall be controlled via digital controllers with inputs from airflow control measuring stations and static pressure inputs as specified. Controller outputs shall be analog or pulse width modulating output signals. The controllers shall include the capability to control via simple proportional (P) control, proportional plus integral (PI), proportional plus integral plus derivative (PID), and on-off. The airflow control programs shall be factory-tested programs that are documented in the literature of the control manufacturer.
- B. Air Flow Measuring Station -- Electronic Thermal Type:
 1. Air Flow Sensor Probe:
 - a. Each air flow sensor shall contain two individual thermal sensing elements. One element shall determine the velocity of the air stream while the other element shall compensate for changes in temperature. Each thermal flow sensor and its associated control circuit and signal conditioning circuit shall be factory calibrated and be interchangeable to allow replacement of a sensor without recalibration of the entire flow station. The sensor in the array shall be located at the center of equal area segment of the duct and the number of sensors shall be adequate to accommodate the expected velocity profile and variation in flow and temperature. The airflow station shall be of the

insertion type in which sensor support structures are inserted from the outside of the ducts to make up the complete electronic velocity array.

- b. Thermal flow sensor shall be constructed of hermetically sealed thermistors or nickel chromium or reference grade platinum wire, wound over an epoxy, stainless steel or ceramic mandrel and coated with a material suitable for the conditions to be encountered. Each dual sensor shall be mounted in an extruded aluminum alloy strut.
2. Air Flow Sensor Grid Array:
- a. Each sensor grid shall consist of a lattice network of temperature sensors and linear integral controllers (ICs) situated inside an aluminum casing suitable for mounting in a duct. Each sensor shall be mounted within a strut facing downstream of the airflow and located so that it is protected on the upstream side. All wiring shall be encased (out of the air stream) to protect against mechanical damage.
 - b. The casing shall be made of welded aluminum of sufficient strength to prevent structural bending and bowing. Steel or iron composite shall not be acceptable in the casing material.
 - c. Pressure drop through the flow station shall not exceed 4 Pascal (0.015" W.G.) at 1,000 meter per minute (3,000 FPM).
3. Electronics Panel:
- a. Electronics Panel shall consist of a surface mounted enclosure complete with solid-state microprocessor and software.
 - b. Electronics Panel shall be A/C powered 120 VAC and shall have the capability to transmit signals of 0-5 VDC, 0-10 VCD or 4-20 ma for use in control of the HVAC Systems. The electronic panel shall have the capability to accept user defined scaling parameters for all output signals.
 - c. Electronics Panel shall have the capability to digitally display airflow in CFM and temperature in degrees F. The displays shall be provided as an integral part of the electronics panel. The electronic panel shall have the capability to totalize the output flow in CFM for two or more systems, as required. A single output signal may be provided which will equal the sum of the systems

totalized. Output signals shall be provided for temperature and airflow. Provide remote mounted air flow or temperature displays where indicated on the plans.

- d. Electronics Panel shall have the following:
 - 1) Minimum of 12-bit A/D conversion.
 - 2) Field adjustable digital primary output offset and gain.
 - 3) Airflow analog output scaling of 100 to 10,000 FPM.
 - 4) Temperature analog output scaling from -45°C to 70°C (-50°F to 160°F).
 - 5) Analog output resolution (full scale output) of 0.025%.
- e. All readings shall be in I.P. units.
- 4. Thermal flow sensors and its electronics shall be installed as per manufacturer's instructions. The probe sensor density shall be as follows:

Probe Sensor Density	
Area (sq.ft.)	Qty. Sensors
<=1	2
>1 to <4	4
4 to <8	6
8 to <12	8
12 to <16	12
>=16	16

- a. Complete installation shall not exhibit more than $\pm 2.0\%$ error in airflow measurement output for variations in the angle of flow of up to 10 percent in any direction from its calibrated orientation. Repeatability of readings shall be within $\pm 0.25\%$.
- C. Static Pressure Measuring Station: shall consist of one or more static pressure sensors and transmitters along with relays or auxiliary devices as required for a complete functional system. The span of the transmitter shall not exceed two times the design static pressure at the point of measurement. The output of the transmitter shall be true representation of the input pressure with plus or minus 25 Pascal (0.1 inch) W.G. of the true input pressure:

1. Static pressure sensors shall have the same requirements as Airflow Measuring Devices except that total pressure sensors are optional, and only multiple static pressure sensors positioned on an equal area basis connected to a network of headers are required.
 2. For systems with multiple major trunk supply ducts, furnish a static pressure transmitter for each trunk duct. The transmitter signal representing the lowest static pressure shall be selected and this shall be the input signal to the controller.
 3. The controller shall receive the static pressure transmitter signal and CU shall provide a control output signal to the supply fan capacity control device. The control mode shall be proportional plus integral (PI) (automatic reset) and where required shall also include derivative mode.
 4. In systems with multiple static pressure transmitters, provide a switch located near the fan discharge to prevent excessive pressure during abnormal operating conditions. High-limit switches shall be manually-reset.
- D. Constant Volume Control Systems shall consist of an air flow measuring station along with such relays and auxiliary devices as required to produce a complete functional system. The transmitter shall receive its air flow signal and static pressure signal from the flow measuring station and shall have a span not exceeding three times the design flow rate. The CU shall receive the transmitter signal and shall provide an output to the fan volume control device to maintain a constant flow rate. The CU shall provide proportional plus integral (PI) (automatic reset) control mode and where required also inverse derivative mode. Overall system accuracy shall be plus or minus the equivalent of 2 Pascal (0.008 inch) velocity pressure as measured by the flow station.
- E. Airflow Synchronization:
1. Systems shall consist of an air flow measuring station for each supply and return duct, the CU and such relays, as required to provide a complete functional system that will maintain a constant flow rate difference between supply and return air to an accuracy of $\pm 10\%$. In systems where there is no suitable location for a flow measuring station that will sense total supply or return flow,

provide multiple flow stations with a differential pressure transmitter for each station. Signals from the multiple transmitters shall be added through the CU such that the resultant signal is a true representation of total flow.

2. The total flow signals from supply and return air shall be the input signals to the CU. This CU shall track the return air fan capacity in proportion to the supply air flow under all conditions.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Examine project plans for control devices and equipment locations; and report any discrepancies, conflicts, or omissions to Contracting Officer Technical Representative for resolution before proceeding for installation.
2. Install equipment, piping, wiring /conduit parallel to or at right angles to building lines.
3. Install all equipment and piping in readily accessible locations. Do not run tubing and conduit concealed under insulation or inside ducts.
4. Mount control devices, tubing and conduit located on ducts and apparatus with external insulation on standoff support to avoid interference with insulation.
5. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
6. Run tubing and wire connecting devices on or in control cabinets parallel with the sides of the cabinet neatly racked to permit tracing.
7. Install equipment level and plum.

B. Electrical Wiring Installation:

1. All wiring cabling shall be installed in conduits. Install conduits and wiring in accordance with Specification Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS. Conduits carrying control wiring and cabling shall be dedicated to the control wiring and cabling: these conduits shall not carry power wiring. Provide plastic end sleeves at all conduit terminations to protect wiring from burrs.

2. Install analog signal and communication cables in conduit and in accordance with Specification Section 26 05 21. Install digital communication cables in conduit and in accordance with Specification Section 27 15 00, Communications Horizontal Cabling.
3. Install conduit and wiring between operator workstation(s), digital controllers, electrical panels, indicating devices, instrumentation, miscellaneous alarm points, thermostats, and relays as shown on the drawings or as required under this section.
4. Install all electrical work required for a fully functional system and not shown on electrical plans or required by electrical specifications. Where low voltage (less than 50 volt) power is required, provide suitable Class B transformers.
5. Install all system components in accordance with local Building Code and National Electric Code.
 - a. Splices: Splices in shielded and coaxial cables shall consist of terminations and the use of shielded cable couplers. Terminations shall be in accessible locations. Cables shall be harnessed with cable ties.
 - b. Equipment: Fit all equipment contained in cabinets or panels with service loops, each loop being at least 300 mm (12 inches) long. Equipment for fiber optics system shall be rack mounted, as applicable, in ventilated, self-supporting, code gauge steel enclosure. Cables shall be supported for minimum sag.
 - c. Cable Runs: Keep cable runs as short as possible. Allow extra length for connecting to the terminal board. Do not bend flexible coaxial cables in a radius less than ten times the cable outside diameter.
 - d. Use vinyl tape, sleeves, or grommets to protect cables from vibration at points where they pass around sharp corners, through walls, panel cabinets, etc.
6. Conceal cables, except in mechanical rooms and areas where other conduits and piping are exposed.
7. Permanently label or code each point of all field terminal strips to show the instrument or item served. Color-coded cable with cable diagrams may be used to accomplish cable identification.
8. Grounding: ground electrical systems per manufacturer's written requirements for proper and safe operation.

C. Install Sensors and Controls:

1. Temperature Sensors:

- a. Install all sensors and instrumentation according to manufacturer's written instructions. Temperature sensor locations shall be readily accessible, permitting quick replacement and servicing of them without special skills and tools.
- b. Calibrate sensors to accuracy specified, if not factory calibrated.
- c. Use of sensors shall be limited to its duty, e.g., duct sensor shall not be used in lieu of room sensor.
- d. Install room sensors permanently supported on wall frame. They shall be mounted at 1.5 meter (5.0 feet) above the finished floor.
- e. Mount sensors rigidly and adequately for the environment within which the sensor operates. Separate extended-bulb sensors from contact with metal casings and coils using insulated standoffs.
- f. Sensors used in mixing plenum, and hot and cold decks shall be of the averaging of type. Averaging sensors shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip.
- g. All pipe mounted temperature sensors shall be installed in wells.
- h. All wires attached to sensors shall be air sealed in their conduits or in the wall to stop air transmitted from other areas affecting sensor reading.
- i. Permanently mark terminal blocks for identification. Protect all circuits to avoid interruption of service due to short-circuiting or other conditions. Line-protect all wiring that comes from external sources to the site from lightning and static electricity.

2. Pressure Sensors:

- a. Install duct static pressure sensor tips facing directly downstream of airflow.
- b. Install high-pressure side of the differential switch between the pump discharge and the check valve.
- c. Install snubbers and isolation valves on steam pressure sensing devices.

3. Actuators:

- a. Mount and link damper and valve actuators according to manufacturer's written instructions.
- b. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed position.
- c. Check operation of valve/actuator combination to confirm that actuator modulates valve smoothly in both open and closed position.

4. Flow Switches:

- a. Install flow switch according to manufacturer's written instructions.
- b. Mount flow switch a minimum of 5 pipe diameters up stream and 5 pipe diameters downstream or 600 mm (2 feet) whichever is greater, from fittings and other obstructions.
- c. Assure correct flow direction and alignment.
- d. Mount in horizontal piping-flow switch on top of the pipe.

D. Installation of network:

1. Ethernet:

- a. The network shall employ Ethernet LAN architecture, as defined by IEEE 802.3. The Network Interface shall be fully Internet Protocol (IP) compliant allowing connection to currently installed IEEE 802.3, Compliant Ethernet Networks.
- b. The network shall directly support connectivity to a variety of cabling types. As a minimum provide the following connectivity: 100 Base TX (Category 5e cabling) for the communications between the ECC and the B-BC and the B-AAC controllers.

- 2. Third party interfaces: Contractor shall integrate real-time data from building systems by other trades and databases originating from other manufacturers as specified and required to make the system work as one system.

E. Installation of digital controllers and programming:

- 1. Provide a separate digital control panel for each major piece of equipment, such as air handling unit, chiller, pumping unit etc. Points used for control loop reset such as outdoor air, outdoor humidity, or space temperature could be located on any of the remote control units.

2. Provide sufficient internal memory for the specified control sequences and trend logging. There shall be a minimum of 25 percent of available memory free for future use.
3. System point names shall be modular in design, permitting easy operator interface without the use of a written point index.
4. Provide software programming for the applications intended for the systems specified, and adhere to the strategy algorithms provided.
5. Provide graphics for each piece of equipment and floor plan in the building. This includes each chiller, cooling tower, air handling unit, fan, terminal unit, boiler, pumping unit etc. These graphics shall show all points dynamically as specified in the point list.

3.2 SYSTEM VALIDATION AND DEMONSTRATION

- A. As part of final system acceptance, a system demonstration is required (see below). Prior to start of this demonstration, the contractor is to perform a complete validation of all aspects of the controls and instrumentation system.
- B. Validation
 1. Prepare and submit for approval a validation test plan including test procedures for the performance verification tests. Test Plan shall address all specified functions of the ECC and all specified sequences of operation. Explain in detail actions and expected results used to demonstrate compliance with the requirements of this specification. Explain the method for simulating the necessary conditions of operation used to demonstrate performance of the system. Test plan shall include a test check list to be used by the Installer's agent to check and initial that each test has been successfully completed. Deliver test plan documentation for the performance verification tests to the owner's representative 30 days prior to start of performance verification tests. Provide draft copy of operation and maintenance manual with performance verification test.
 2. After approval of the validation test plan, installer shall carry out all tests and procedures therein. Installer shall completely check out, calibrate, and test all connected hardware and software to insure that system performs in accordance with approved specifications and sequences of operation submitted. Installer shall complete and submit Test Check List.

C. Demonstration

1. System operation and calibration to be demonstrated by the installer in the presence of the Architect or VAMC's representative on random samples of equipment as dictated by the Architect or VAMC's representative. Should random sampling indicate improper commissioning, the owner reserves the right to subsequently witness complete calibration of the system at no addition cost to the VAMC.
2. Demonstrate to authorities that all required safeties and life safety functions are fully functional and complete.
3. Make accessible, personnel to provide necessary adjustments and corrections to systems as directed by balancing agency.
4. The following witnessed demonstrations of field control equipment shall be included:
 - a. Observe HVAC systems in shut down condition. Check dampers and valves for normal position.
 - b. Test application software for its ability to communicate with digital controllers, operator workstation, and uploading and downloading of control programs.
 - c. Demonstrate the software ability to edit the control program off-line.
 - d. Demonstrate reporting of alarm conditions for each alarm and ensure that these alarms are received at the assigned location, including operator workstations.
 - e. Demonstrate ability of software program to function for the intended applications-trend reports, change in status etc.
 - f. Demonstrate via graphed trends to show the sequence of operation is executed in correct manner, and that the HVAC systems operate properly through the complete sequence of operation, e.g., seasonal change, occupied/unoccupied mode, and warm-up condition.
 - g. Demonstrate hardware interlocks and safeties functions, and that the control systems perform the correct sequence of operation after power loss and resumption of power loss.
 - h. Prepare and deliver to the VAMC graphed trends of all control loops to demonstrate that each control loop is stable and the setpoints are maintained.

- i. Demonstrate that each control loop responds to setpoint adjustment and stabilizes within one (1) minute. Control loop trend data shall be instantaneous and the time between data points shall not be greater than one (1) minute.

----- END -----

**SECTION 23 11 23
FACILITY NATURAL-GAS PIPING**

PART 1 - GENERAL

1.1 DESCRIPTION

Fuel gas systems, including piping, equipment and all necessary accessories as designated in this section. Fuel gas piping for central boiler plants is not included.

1.2 RELATED WORK

- A. Penetrations in rated enclosures: Section 07 84 00, FIRESTOPPING.
- B. Preparation and finish painting and identification of piping systems: Section 09 91 00, PAINTING.
- C. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- D. Pipe Insulation: Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION.

1.3 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data:
 - 1. Piping.
 - 2. Strainers.
 - 3. All items listed in Part 2 - Products.

1.4 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. Federal Specifications (Fed. Spec.):
 - A-A-59617.....Unions, Brass or Bronze Threaded, Pipe
Connections and Solder-Joint Tube Connections
- C. American National Standards Institute (ANSI):
 - American Society of Mechanical Engineers (ASME): (Copyrighted Society)
 - A13.1-96.....Scheme for Identification of Piping Systems
 - B16.3-98.....Malleable Iron Threaded Fittings ANSI/ASME
 - B16.9-01.....Factory-Made Wrought Steel Buttwelding Fittings
ANSI/ASME
 - B16.11-01.....Forged Steel Fittings, Socket-Welding and
Threaded ANSI/ASME
 - B16.15-85(R 1994).....Cast Bronze Threaded Fittings ANSI/ASME

B31.8-01.....Gas Transmission and Distribution Piping
Systems ANSI/ASME

D. American Society for Testing and Materials (ASTM):

A47-99.....Ferritic Malleable Iron Castings Revision 1989

A53-02.....Pipe, Steel, Black And Hot-Dipped, Zinc-coated
Welded and Seamless

A183-83(R1998).....Carbon Steel Track Bolts and Nuts

A536-84(R1999) E1.....Ductile Iron Castings

A733-03.....Welded and Seamless Carbon Steel and Austenitic
Stainless Steel Pipe Nipples

B687-99.....Brass, Copper, and Chromium-Plated Pipe Nipples

E. National Fire Protection Association (NFPA):

54-92.....National Fuel Gas Code

F. National Association of Plumbing - Heating - Cooling Contractors
(PHCC):

National Standard Plumbing Code - 1996

G. International Association of Plumbing and Mechanical Officials (IAPMO):
Uniform Plumbing Code - 2000

IS6-93.....Installation Standard

H. Manufacturers Standardization Society of the Valve and Fittings
Industry, Inc. (MSS):

SP-72-99.....Ball Valves With Flanged or Butt Welding For
General Purpose

SP-110-96.....Ball Valve Threaded, Socket Welding, Solder
Joint, Grooved and Flared Ends

PART 2 - PRODUCTS

2.1 FUEL GAS PIPING

A. Pipe: Black steel, ASTM A53, Schedule 40.

B. Nipples: Steel, ASTM A733, Schedule 40.

C. Fittings:

1. Steel Welded: Schedule 40

a. Up to 100 mm (4 inch), ANSI B16.11, Socket welded.

b. Over 100 mm (4 inch), ANSI B16.9, Butt welded.

2. Malleable Iron, Threaded: ANSI B16.3.

3. Grooved End: Ductile iron (ASTM A536, Grade 65-45-12), malleable
iron (ASTM A47, Grade 32510), or steel (ASTM A53, Type F or Type E
or S, Grade B).

D. Joints: Provide welded or threaded joints.

2.2 EXPOSED FUEL GAS PIPING

- A. Finished Room: Use full iron pipe size chrome plated brass piping for exposed fuel gas piping connecting fixtures, casework, cabinets, equipment and reagent racks when not concealed by apron including those furnished by the Government or specified in other sections.
 - 1. Pipe: Fed. Spec. WW-P-351, standard weight.
 - 2. Fittings: ANSI B16.15 cast bronze threaded fittings with chrome finish, (125 and 250).
 - 3. Nipples: ASTM B 687, Chromium-plated.
 - 4. Unions: Mss SP-72, SP-110, Brass or Bronze with chrome finish. Unions 65 mm (2-1/2 inches) and larger shall be flange type with approved gaskets.
 - 5. Valves: Mss SP-72, SP-110, Brass or bronze with chrome finish.
- B. Unfinished Rooms, Mechanical Rooms and Kitchens: Chrome-plated brass piping is not required. Paint piping systems as specified in Section 09 91 00, PAINTING.

2.3 WATERPROOFING

- A. Floors: Provide cast iron stack sleeve with flashing device and a underdeck clamp. After stack is passed through sleeve, provide a waterproofed caulked joint at top hub.
- B. Walls: See detail shown on drawings.

2.4 DIELECTRIC FITTINGS

Provide dielectric couplings or unions between ferrous and non-ferrous pipe.

2.5 GAS EQUIPMENT CONNECTORS

Flexible connectors with Teflon core, interlocked galvanized steel protective casing, AGA certified design.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Comply with the PHCC National Standard Plumbing Code and the following:
 - 1. Install branch piping for fuel gas and connect to all fixtures, valves, cocks, outlets, casework, cabinets and equipment, including those furnished by the Government or specified in other sections.
 - 2. Pipe shall be round and straight. Cutting shall be done with proper tools. Pipe, except for plastic and glass, shall be reamed to full size after cutting.

3. All pipe runs shall be laid out to avoid interference with other work.
4. Install valves with stem in horizontal position whenever possible. All valves shall be easily accessible.
5. Install union and shut-off valve on pressure piping at connections to equipment.
6. Pipe Hangers, Supports And Accessories:
 - a. All piping shall be supported per of the National Standard Plumbing Code, Chapter No. 8.
 - b. Shop Painting and Plating: Hangers, supports, rods, inserts and accessories used for Pipe supports shall be shop coated with red lead or zinc Chromate primer paint. Electroplated copper hanger rods, hangers and accessories may be used with copper tubing.
 - c. Floor, Wall and Ceiling Plates, Supports, Hangers:
 - 1) Solid or split unplated cast iron.
 - 2) All plates shall be provided with set screws.
 - 3) Pipe Hangers: Height adjustable clevis type.
 - 4) Adjustable Floor Rests and Base Flanges: Steel.
 - 5) Concrete Inserts: "Universal" or continuous slotted type.
 - 6) Hanger Rods: Mild, low carbon steel, fully threaded or Threaded at each end with two removable nuts at each end for positioning rod and hanger and locking each in place.
 - 7) Riser Clamps: Malleable iron or steel.
 - 8) Rollers: Cast iron.
 - 9) Self-drilling type expansion shields shall be "Phillips" type, with case hardened steel expander plugs.
 - 10) Hangers and supports utilized with insulated pipe and tubing shall have 180 degree (min.) metal protection shield Centered on and welded to the hanger and support. The shield shall be 4 inches in length and be 16 gauge steel. The shield shall be sized for the insulation.
 - 11) Miscellaneous Materials: As specified, required, directed or as noted on the drawings for proper installation of hangers, supports and accessories. If the vertical distance exceeds 6 m (20 feet) for cast iron pipe additional support shall be provided in the center of that span. Provide all necessary auxiliary steel to provide that support.

7. Install cast escutcheon with set screw at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.
8. Penetrations:
 - a. Fire Stopping: Where pipes pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases as specified in Section 07 84 00, FIRESTOPPING. Completely fill and seal clearances between raceways and openings with the fire stopping materials.
 - b. Waterproofing: At floor penetrations, completely seal clearances around the pipe and make watertight with sealant as specified in Section 07 92 00, JOINT SEALANTS.
- B. Piping shall conform to the following:
 1. Fuel Gas:
 - a. Entire fuel gas piping installation shall be in accordance with requirements of NFPA 54.
 - b. Install fuel gas piping with plugged drip pockets at low points.

3.2 TESTS

- A. General: Test system either in its entirety or in sections.
- B. Fuel Gas System: NFPA 54.

- - - E N D - - -

**SECTION 23 21 13
HYDRONIC PIPING**

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Water piping to connect HVAC equipment, including the following:
 - 1. Chilled water, heating hot water and drain piping.

1.2 RELATED WORK

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- C. Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION:
General mechanical requirements and items, which are common to more than one section of Division 23.
- D. Section 23 07 11, HVAC, PLUMBING, and BOILER PLANT INSULATION: Piping insulation.
- E. Section 23 23 00, REFRIGERANT PIPING: Refrigerant piping and refrigerants.
- F. Section 23 25 00, HVAC WATER TREATMENT: Water treatment for open and closed systems.
- G. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC: Temperature and pressure sensors and valve operators.

1.3 QUALITY ASSURANCE

- A. Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION, which includes welding qualifications.
- B. Submit prior to welding of steel piping a certificate of Welder's certification. The certificate shall be current and not more than one year old.
- C. For mechanical pressed sealed fittings, only tools of fitting manufacturer shall be used.
- D. Mechanical pressed fittings shall be installed by factory trained workers.
- E. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be the same manufacturer as the grooved components.
 - 1. All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.

1.4 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data:
 - 1. Pipe and equipment supports.
 - 2. Pipe and tubing, with specification, class or type, and schedule.
 - 3. Pipe fittings, including miscellaneous adapters and special fittings.
 - 4. Flanges, gaskets and bolting.
 - 5. Grooved joint couplings and fittings.
 - 6. Valves of all types.
 - 7. Strainers.
 - 8. Flexible connectors for water service.
 - 9. Pipe alignment guides.
 - 10. Expansion joints.
 - 11. Expansion compensators.
 - 12. All specified hydronic system components.
 - 13. Gages.
 - 14. Thermometers and test wells.
 - 15. Electric heat tracing systems.
- C. Submit the welder's qualifications in the form of a current (less than one year old) and formal certificate.
- D. Coordination Drawings: Refer to Article, SUBMITTALS of Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- E. As-Built Piping Diagrams: Provide drawing as follows for chilled water, condenser water, and heating hot water system and other piping systems and equipment.
 - 1. One wall-mounted stick file with complete set of prints. Mount stick file in the chiller plant or control room along with control diagram stick file.
 - 2. One complete set of reproducible drawings.
 - 3. One complete set of drawings in electronic AutoCAD and pdf format.

1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only. American National Standards Institute, Inc.

- B. American Society of Mechanical Engineers/American National Standards Institute, Inc. (ASME/ANSI):
- B1.20.1-83(R2006).....Pipe Threads, General Purpose (Inch)
 - B16.4-06.....Gray Iron Threaded FittingsB16.18-01 Cast
Copper Alloy Solder joint Pressure fittings
 - B16.23-02.....Cast Copper Alloy Solder joint Drainage
fittings
 - B40.100-05.....Pressure Gauges and Gauge Attachments
- C. American National Standards Institute, Inc./Fluid Controls Institute (ANSI/FCI):
- 70-2-2006.....Control Valve Seat Leakage
- D. American Society of Mechanical Engineers (ASME):
- B16.1-98.....Cast Iron Pipe Flanges and Flanged Fittings
 - B16.3-2006.....Malleable Iron Threaded Fittings: Class 150 and
300
 - B16.4-2006.....Gray Iron Threaded Fittings: (Class 125 and
250)
 - B16.5-2003.....Pipe Flanges and Flanged Fittings: NPS ½
through NPS 24 Metric/Inch Standard
 - B16.9-07.....Factory Made Wrought Butt Welding Fittings
 - B16.11-05.....Forged Fittings, Socket Welding and Threaded
 - B16.18-01.....Cast Copper Alloy Solder Joint Pressure
Fittings
 - B16.22-01.....Wrought Copper and Bronze Solder Joint Pressure
Fittings.
 - B16.24-06.....Cast Copper Alloy Pipe Flanges and Flanged
Fittings
 - B16.39-06.....Malleable Iron Threaded Pipe Unions
 - B16.42-06.....Ductile Iron Pipe Flanges and Flanged Fittings
 - B31.1-08.....Power Piping
- E. American Society for Testing and Materials (ASTM):
- A47/A47M-99 (2004).....Ferritic Malleable Iron Castings
 - A53/A53M-07.....Standard Specification for Pipe, Steel, Black
and Hot-Dipped, Zinc-Coated, Welded and
Seamless
 - A106/A106M-08.....Standard Specification for Seamless Carbon
Steel Pipe for High-Temperature Service

- A126-04.....Standard Specification for Gray Iron Castings
for Valves, Flanges, and Pipe Fittings
- A183-03 Standard Specification for Carbon Steel Track
Bolts and Nuts
- A216/A216M-08 Standard Specification for Steel Castings,
Carbon, Suitable for Fusion Welding, for High
Temperature Service
- A234/A234M-07 Piping Fittings of Wrought Carbon Steel and
Alloy Steel for Moderate and High Temperature
Service
- A307-07 Standard Specification for Carbon Steel Bolts
and Studs, 60,000 PSI Tensile Strength
- A536-84 (2004) Standard Specification for Ductile Iron Castings
- A653/A 653M-08 Steel Sheet, Zinc-Coated (Galvanized) or Zinc-
Iron Alloy Coated (Galvannealed) By the Hot-Dip
Process
- B32-08 Standard Specification for Solder Metal
- B62-02 Standard Specification for Composition Bronze or
Ounce Metal Castings
- B88-03 Standard Specification for Seamless Copper Water
Tube
- F439-06 Standard Specification for Chlorinated Poly
(Vinyl Chloride) (CPVC) Plastic Pipe Fittings,
Schedule 80
- F. American Welding Society (AWS):
- B2.1-02.....Standard Welding Procedure Specification
- G. Copper Development Association, Inc. (CDA):
- CDA A4015-06.....Copper Tube Handbook
- H. Expansion Joint Manufacturer's Association, Inc. (EJMA):
- EMJA-2003.....Expansion Joint Manufacturer's Association
Standards, Ninth Edition
- I. Manufacturers Standardization Society (MSS) of the Valve and Fitting
Industry, Inc.:
- SP-67-02a.....Butterfly Valves
- SP-70-06.....Gray Iron Gate Valves, Flanged and Threaded
Ends
- SP-71-05.....Gray Iron Swing Check Valves, Flanged and
Threaded Ends

- B. 65 mm (2-1/2 inches) and Larger: Welded or flanged joints. Contractor's option: Grooved mechanical couplings and fittings are optional.
 - 1. Butt welding fittings: ASME B16.9 with same wall thickness as connecting piping. Elbows shall be long radius type, unless otherwise noted.
 - 2. Welding flanges and bolting: ASME B16.5:
 - a. Water service: Weld neck or slip-on, plain face, with 6 mm (1/8 inch) thick full face neoprene gasket suitable for 104 degrees C (220 degrees F).
 - 1) Contractor's option: Convoluted, cold formed 150 pound steel flanges, with teflon gaskets, may be used for water service.
 - b. Flange bolting: Carbon steel machine bolts or studs and nuts, ASTM A307, Grade B.
- C. Welded Branch and Tap Connections: Forged steel weldolets, or branchlets and threadolets may be used for branch connections up to one pipe size smaller than the main. Forged steel half-couplings, ASME B16.11 may be used for drain, vent and gage connections.
- D. Grooved Mechanical Pipe Couplings and Fittings (Contractor's Option): Grooved Mechanical Pipe Couplings and Fittings may be used, with cut or roll grooved pipe, in water service up to 110 degrees C (230 degrees F) in lieu of welded, screwed or flanged connections. All joints must be rigid type.
 - 1. Grooved mechanical couplings: Malleable iron, ASTM A47 or ductile iron, ASTM A536, fabricated in two or more parts, securely held together by two or more track-head, square, or oval-neck bolts, ASTM A449 and A183.
 - 2. Gaskets: Rubber product recommended by the coupling manufacturer for the intended service.
 - 3. Grooved end fittings: Malleable iron, ASTM A47; ductile iron, ASTM A536; or steel, ASTM A53 or A106, designed to accept grooved mechanical couplings. Tap-in type branch connections are acceptable.

2.4 FITTINGS FOR COPPER TUBING

- A. Joints:
 - 1. Solder Joints: Joints shall be made up in accordance with recommended practices of the materials applied. Apply 95/5 tin and antimony on all copper piping.

2. Mechanically formed tee connection in water and drain piping: Form mechanically extracted collars in a continuous operation by drilling pilot hole and drawing out tube surface to form collar, having a height of not less than three times the thickness of tube wall. Adjustable collaring device shall insure proper tolerance and complete uniformity of the joint. Notch and dimple joining branch tube in a single process to provide free flow where the branch tube penetrates the fitting.

B. Bronze Flanges and Flanged Fittings: ASME B16.24.

C. Fittings: ANSI/ASME B16.18 cast copper or ANSI/ASME B16.22 solder wrought copper.

2.5 FITTINGS FOR PLASTIC PIPING

A. Schedule 40, socket type for solvent welding.

B. Schedule 40 PVC drain piping: Drainage pattern.

C. Chemical feed piping for condenser water treatment: Chlorinated polyvinyl chloride (CPVC), Schedule 80, ASTM F439.

2.6 DIELECTRIC FITTINGS

A. Provide where copper tubing and ferrous metal pipe are joined.

B. 50 mm (2 inches) and Smaller: Threaded dielectric union, ASME B16.39.

C. 65 mm (2 1/2 inches) and Larger: Flange union with dielectric gasket and bolt sleeves, ASME B16.42.

D. Temperature Rating, 99 degrees C (210 degrees F).

2.7 SCREWED JOINTS

A. Pipe Thread: ANSI B1.20.

B. Lubricant or Sealant: Oil and graphite or other compound approved for the intended service.

2.8 VALVES

A. Asbestos packing is not acceptable.

B. All valves of the same type shall be products of a single manufacturer.

C. Provide chain operators for valves 150 mm (6 inches) and larger when the centerline is located 2400 mm (8 feet) or more above the floor or operating platform.

D. Shut-Off Valves

1. Ball Valves (Pipe sizes 2" and smaller): MSS-SP 110, screwed or solder connections, brass or bronze body with chrome-plated ball with full port and Teflon seat at 2760 kPa (400 psig) working pressure rating. Provide stem extension to allow operation without interfering with pipe insulation.

2. Butterfly Valves (Pipe Sizes 2-1/2" and larger): Provide stem extension to allow 50 mm (2 inches) of pipe insulation without interfering with valve operation. MSS-SP 67, flange lug type or grooved end rated 1205 kPa (175 psig) working pressure at 93 degrees C (200 degrees F). Valves shall be ANSI Leakage Class VI and rated for bubble tight shut-off to full valve pressure rating. Valve shall be rated for dead end service and bi-directional flow capability to full rated pressure. Not permitted for direct buried pipe applications.

- a. Body: Cast iron, ASTM A126, Class B. Malleable iron, ASTM A47 electro-plated, or ductile iron, ASTM A536, Grade 65-45-12 electro-plated.
- b. Trim: Bronze, aluminum bronze, or 300 series stainless steel disc, bronze bearings, 316 stainless steel shaft and manufacturer's recommended resilient seat. Resilient seat shall be field replaceable, and fully line the body to completely isolate the body from the product. A phosphate coated steel shaft or stem is acceptable, if the stem is completely isolated from the product.
- c. Actuators: Field interchangeable. Valves for balancing service shall have adjustable memory stop to limit open position.
 - 1) Valves 150 mm (6 inches) and smaller: Lever actuator with minimum of seven locking positions, except where chain wheel is required.
 - 2) Valves 200 mm (8 inches) and larger: Enclosed worm gear with handwheel, and where required, chain-wheel operator.
 - 3) 3. Gate Valves (Contractor's Option in lieu of Ball or Butterfly Valves):
 - a) 50 mm (2 inches) and smaller: MSS-SP 80, Bronze, 1034 kPa (150 psig), wedge disc, rising stem, union bonnet.
 - b) 65 mm (2 1/2 inches) and larger: Flanged, outside screw and yoke. MSS-SP 70, iron body, bronze mounted, 861 kPa (125 psig) wedge disc.

E. Globe and Angle Valves

1. Globe Valves

- a. 50 mm (2 inches) and smaller: MSS-SP 80, bronze, 1034 kPa (150 lb.) Globe valves shall be union bonnet with metal plug type disc.

- b. 65 mm (2 1/2 inches) and larger: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS-SP-85 for globe valves.
- 2. Angle Valves:
 - a. 50 mm (2 inches) and smaller: MSS-SP 80, bronze, 1034 kPa (150 lb.) Angle valves shall be union bonnet with metal plug type disc.
 - b. 65 mm (2 1/2 inches) and larger: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS-SP-85 for angle.
- F. Check Valves
 - 1. Swing Check Valves:
 - a. 50 mm (2 inches) and smaller: MSS-SP 80, bronze, 1034 kPa (150 lb.), 45 degree swing disc.
 - b. 65 mm (2 1/2 inches) and larger: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS-SP-71 for check valves.
 - 2. Non-Slam or Silent Check Valve: Spring loaded double disc swing check or internally guided flat disc lift type check for bubble tight shut-off. Provide where check valves are shown in chilled water and hot water piping. Check valves incorporating a balancing feature may be used.
 - a. Body: MSS-SP 125 cast iron, ASTM A126, Class B, or steel, ASTM A216, Class WCB, or ductile iron, ASTM 536, flanged, grooved, or wafer type.
 - b. Seat, disc and spring: 18-8 stainless steel, or bronze, ASTM B62. Seats may be elastomer material.
- G. Water Flow Balancing Valves: For flow regulation and shut-off. Valves shall be line size rather than reduced to control valve size.
 - 1. Ball or Globe style valve.
 - 2. A dual purpose flow balancing valve and adjustable flow meter, with bronze or cast iron body, calibrated position pointer, valved pressure taps or quick disconnects with integral check valves and preformed polyurethane insulating enclosure.
 - 3. Provide a readout kit including flow meter, readout probes, hoses, flow charts or calculator, and carrying case.
- H. Automatic Balancing Control Valves: Factory calibrated to maintain constant flow (plus or minus five percent) over system pressure fluctuations of at least 10 times the minimum required for control. Provide standard pressure taps and four sets of capacity charts. Valves shall be line size and be one of the following designs:

1. Gray iron (ASTM A126) or brass body rated 1205 kPa (175 psig) at 93 degrees C (200 degrees F), with stainless steel piston and spring.
2. Brass or ferrous body designed for 2067 kPa (300 psig) service at 121 degrees C (250 degrees F), with corrosion resistant, tamper proof, self-cleaning piston/spring assembly that is easily removable for inspection or replacement.
3. Combination assemblies containing ball type shut-off valves, unions, flow regulators, strainers with blowdown valves and pressure temperature ports shall be acceptable.

2.9 STRAINERS

A. Y Type.

1. Screens: Bronze, monel metal or 18-8 stainless steel, free area not less than 2-1/2 times pipe area, with perforations as follows: 1.1 mm (0.045 inch) diameter perforations for 100 mm (4 inches) and larger: 3.2 mm (0.125 inch) diameter perforations.

2.10 HYDRONIC SYSTEM COMPONENTS

Automatic Air Vent Valves: Cast iron or semi-steel body, 1034 kPa (150 psig) working pressure, stainless steel float, valve, valve seat and mechanism, minimum 15 mm (1/2 inch) water connection and 6 mm (1/4 inch) air outlet. Air outlet shall be piped to the nearest floor drain.

2.11 GAGES, PRESSURE AND COMPOUND

- A. ASME B40.100, Accuracy Grade 1A, (pressure, vacuum, or compound for air, oil or water), initial mid-scale accuracy 1 percent of scale (Qualify grade), metal or phenolic case, 115 mm (4-1/2 inches) in diameter, 6 mm (1/4 inch) NPT bottom connection, white dial with black graduations and pointer, clear glass or acrylic plastic window, suitable for board mounting. Provide red "set hand" to indicate normal working pressure.
- B. Provide brass lever handle union cock. Provide brass/bronze pressure snubber for gages in water service.
- C. Range of Gages: Provide range equal to at least 130 percent of normal operating range.

2.12 PRESSURE/TEMPERATURE TEST PROVISIONS

- A. Pete's Plug: 6 mm (1/4 inch) MPT by 75 mm (3 inches) long, brass body and cap, with retained safety cap, nordel self-closing valve cores, permanently installed in piping where shown, or in lieu of pressure gage test connections shown on the drawings.
- B. Provide one each of the following test items to the Contracting Officer Technical Representative:
 - 1. 6 mm (1/4 inch) FPT by 3 mm (1/8 inch) diameter stainless steel pressure gage adapter probe for extra long test plug. PETE'S 500 XL is an example.
 - 2. 90 mm (3-1/2 inch) diameter, one percent accuracy, compound gage, -- 100 kPa (30 inches) Hg to 700 kPa (100 psig) range.
 - 3. 0 - 104 degrees C (220 degrees F) pocket thermometer one-half degree accuracy, 25 mm (one inch) dial, 125 mm (5 inch) long stainless steel stem, plastic case.

2.13 THERMOMETERS

- A. Mercury or organic liquid filled type, red or blue column, clear plastic window, with 150 mm (6 inch) brass stem, straight, fixed or adjustable angle as required for each in reading.
- B. Case: Chrome plated brass or aluminum with enamel finish.
- C. Scale: Not less than 225 mm (9 inches), range as described below, two degree graduations.
- D. Separable Socket (Well): Brass, extension neck type to clear pipe insulation.
- E. Scale ranges:
 - 1. Chilled Water and Glycol-Water: 0-38 degrees C (32-100 degrees F).
 - 2. Hot Water and Glycol-Water: -1 - 116 degrees C (30-240 degrees F).

2.14 FIRESTOPPING MATERIAL

Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

PART 3 - EXECUTION**3.1 GENERAL**

- A. The drawings show the general arrangement of pipe and equipment but do not show all required fittings and offsets that may be necessary to connect pipes to equipment, fan-coils, coils, radiators, etc., and to coordinate with other trades. Provide all necessary fittings, offsets and pipe runs based on field measurements and at no additional cost to the government. Coordinate with other trades for space available and

relative location of HVAC equipment and accessories to be connected on ceiling grid. Pipe location on the drawings shall be altered by contractor where necessary to avoid interferences and clearance difficulties.

- B. Store materials to avoid excessive exposure to weather or foreign materials. Keep inside of piping relatively clean during installation and protect open ends when work is not in progress.
- C. Support piping securely. Refer to PART 3, Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION. Install heat exchangers at height sufficient to provide gravity flow of condensate to the flash tank and condensate pump.
- D. Install piping generally parallel to walls and column center lines, unless shown otherwise on the drawings. Space piping, including insulation, to provide 25 mm (one inch) minimum clearance between adjacent piping or other surface. Unless shown otherwise, slope drain piping down in the direction of flow not less than 25 mm (one inch) in 12 m (40 feet). Provide eccentric reducers to keep bottom of sloped piping flat.
- E. Locate and orient valves to permit proper operation and access for maintenance of packing, seat and disc. Generally locate valve stems in overhead piping in horizontal position. Provide a union adjacent to one end of all threaded end valves. Control valves usually require reducers to connect to pipe sizes shown on the drawing. Install butterfly valves with the valve open as recommended by the manufacturer to prevent binding of the disc in the seat.
- F. Offset equipment connections to allow valving off for maintenance and repair with minimal removal of piping. Provide flexibility in equipment connections and branch line take-offs with 3-elbow swing joints where noted on the drawings.
- G. Tee water piping runouts or branches into the side of mains or other branches. Avoid bull-head tees, which are two return lines entering opposite ends of a tee and exiting out the common side.
- H. Provide manual or automatic air vent at all piping system high points and drain valves at all low points. Install piping to floor drains from all automatic air vents.
- I. Connect piping to equipment as shown on the drawings. Install components furnished by others such as:
 - 1. Water treatment pot feeders and condenser water treatment systems.

- 2. Flow elements (orifice unions), control valve bodies, flow switches, pressure taps with valve, and wells for sensors.
- J. Thermometer Wells: In pipes 65 mm (2-1/2 inches) and smaller increase the pipe size to provide free area equal to the upstream pipe area.
- K. Firestopping: Fill openings around uninsulated piping penetrating floors or fire walls, with firestop material. For firestopping insulated piping refer to Section 23 07 11, HVAC, PLUMBING, and BOILER PLANT INSULATION.
- L. Where copper piping is connected to steel piping, provide dielectric connections.

3.2 PIPE JOINTS

- A. Welded: Beveling, spacing and other details shall conform to ASME B31.1 and AWS B2.1. See Welder's qualification requirements under "Quality Assurance" in Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- B. Screwed: Threads shall conform to ASME B1.20; joint compound shall be applied to male threads only and joints made up so no more than three threads show. Coat exposed threads on steel pipe with joint compound, or red lead paint for corrosion protection.
- C. Mechanical Joint: Pipe grooving shall be in accordance with joint manufacturer's specifications. Lubricate gasket exterior including lips, pipe ends and housing interiors to prevent pinching the gasket during installation. Lubricant shall be as recommended by coupling manufacturer.
- D. 125 Pound Cast Iron Flange (Plain Face): Mating flange shall have raised face, if any, removed to avoid overstressing the cast iron flange.
- E. Solvent Welded Joints: As recommended by the manufacturer.

3.3 LEAK TESTING ABOVEGROUND PIPING

- A. Inspect all joints and connections for leaks and workmanship and make corrections as necessary, to the satisfaction of the Contracting Officer Technical Representative. Tests may be either of those below, or a combination, as approved by the Contracting Officer Technical Representative.
- B. An operating test at design pressure, and for hot systems, design maximum temperature.

- C. A hydrostatic test at 1.5 times design pressure. For water systems the design maximum pressure would usually be the static head, or expansion tank maximum pressure, plus pump head. Factory tested equipment (convertors, exchangers, coils, etc.) need not be field tested. Isolate equipment where necessary to avoid excessive pressure on mechanical seals and safety devices.

3.4 FLUSHING AND CLEANING PIPING SYSTEMS

- A. Water Piping: Clean systems as recommended by the suppliers of chemicals specified in Section 23 25 00, HVAC WATER TREATMENT.
1. Initial flushing: Remove loose dirt, mill scale, metal chips, weld beads, rust, and like deleterious substances without damage to any system component. Provide temporary piping or hose to bypass coils, control valves, exchangers and other factory cleaned equipment unless acceptable means of protection are provided and subsequent inspection of hide-out areas takes place. Isolate or protect clean system components, including pumps and pressure vessels, and remove any component which may be damaged. Open all valves, drains, vents and strainers at all system levels. Remove plugs, caps, spool pieces, and components to facilitate early debris discharge from system. Sectionalize system to obtain debris carrying velocity of 1.8 m/S (6 feet per second), if possible. Connect dead-end supply and return headers as necessary. Flush bottoms of risers. Install temporary strainers where necessary to protect down-stream equipment. Supply and remove flushing water and drainage by various type hose, temporary and permanent piping and Contractor's booster pumps. Flush until clean as approved by the Contracting Officer Technical Representative.
 2. Cleaning: Using products supplied in Section 23 25 00, HVAC WATER TREATMENT, circulate systems at normal temperature to remove adherent organic soil, hydrocarbons, flux, pipe mill varnish, pipe joint compounds, iron oxide, and like deleterious substances not removed by flushing, without chemical or mechanical damage to any system component. Removal of tightly adherent mill scale is not required. Keep isolated equipment which is "clean" and where dead-end debris accumulation cannot occur. Sectionalize system if

possible, to circulate at velocities not less than 1.8 m/S (6 feet per second). Circulate each section for not less than four hours. Blow-down all strainers, or remove and clean as frequently as necessary. Drain and prepare for final flushing.

3. Final Flushing: Return systems to conditions required by initial flushing after all cleaning solution has been displaced by clean make-up. Flush all dead ends and isolated clean equipment. Gently operate all valves to dislodge any debris in valve body by throttling velocity. Flush for not less than one hour.

3.5 WATER TREATMENT

- A. Close and fill system as soon as possible after final flushing to minimize corrosion.
- B. Charge systems with chemicals specified in Section 23 25 00, HVAC WATER TREATMENT.
- C. Utilize this activity, by arrangement with the Contracting Officer Technical Representative, for instructing VAMC operating personnel.

3.6 OPERATING AND PERFORMANCE TEST AND INSTRUCTION

- A. Refer to PART 3, Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- B. Adjust red set hand on pressure gages to normal working pressure.

- - - E N D - - -

SECTION 23 22 13
STEAM AND CONDENSATE HEATING PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

Steam, condensate and vent piping located inside buildings.

1.2 RELATED WORK

- A. General mechanical requirements and items, which are common to more than one section of Division 23: Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.
- B. Piping insulation: Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION.
- C. Heating Coils and Humidifiers: Section 23 73 00, INDOOR CENTRAL-STATION AIR-HANDLING UNITS and SECTION 23 31 00, HVAC DUCTS AND CASING.
- D. Heating coils: Section 23 82 16, AIR COILS.
- E. Temperature and pressure sensors and valve operators: Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.

1.3 QUALITY ASSURANCE

Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION, which includes welding qualifications.

1.4 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data:
 - 1. Pipe and equipment supports
 - 2. Pipe and tubing, with specification, class or type, and schedule.
 - 3. Pipe fittings, including miscellaneous adapters and special fittings.
 - 4. Flanges, gaskets and bolting.
 - 5. Valves of all types.
 - 6. Strainers.
 - 7. Pipe alignment guides.
 - 8. Expansion joints.
 - 9. Expansion compensators.
 - 10. Flexible ball joints: Catalog sheets, performance charts, schematic drawings, specifications and installation instructions.
 - 11. All specified steam system components.
 - 12. Gages.
 - 13. Thermometers and test wells.
- C. Coordination Drawings: Refer to Article, SUBMITTALS of Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

D. As-Built Piping Diagrams: Provide drawing as follows for steam and steam condensate piping and other central plant equipment.

1. One wall-mounted stick file for prints. Mount stick file in the chiller plant or adjacent control room along with control diagram stick file.
2. One set of reproducible drawings.

1.5 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

B. American Society of Mechanical Engineers/American National Standards Institute (ASME/ANSI):

B1.20.1-83(R2006).....Pipe Threads, General Purpose (Inch)

B16.4-2006.....Gray Iron Threaded Fittings

C. American Society of Mechanical Engineers (ASME):

B16.1-2005.....Gray Iron Pipe Flanges and Flanged Fittings

B16.3-2006.....Malleable Iron Threaded Fittings

B16.9-2007.....Factory-Made Wrought Buttwelding Fittings

B16.11-2005.....Forged Fittings, Socket-Welding and Threaded

B16.14-91.....Ferrous Pipe Plugs, Bushings, and Locknuts with
Pipe Threads

B16.22-2001.....Wrought Copper and Copper Alloy Solder-Joint
Pressure Fittings

B16.23-2002.....Cast Copper Alloy Solder Joint Drainage Fittings

B16.24-2006.....Cast Copper Alloy Pipe Flanges and Flanged
Fittings, Class 150, 300, 400, 600, 900, 1500
and 2500

B16.39-98.....Malleable Iron Threaded Pipe Unions, Classes
150, 250, and 300

B31.1-2007.....Power Piping

B31.9-2008.....Building Services Piping

B40.100-2005.....Pressure Gauges and Gauge Attachments

Boiler and Pressure Vessel Code: SEC VIII D1-2001, Pressure Vessels,
Division 1

D. American Society for Testing and Materials (ASTM):

A47-99.....Ferritic Malleable Iron Castings

A53-2007.....Pipe, Steel, Black and Hot-Dipped, Zinc-Coated,
Welded and Seamless

A106-2008.....Seamless Carbon Steel Pipe for High-Temperature
Service

- A126-2004.....Standard Specification for Gray Iron Castings
for Valves, Flanges, and Pipe Fittings
- A181-2006.....Carbon Steel Forgings, for General-Purpose
Piping
- A183-2003.....Carbon Steel Track Bolts and Nuts
- A216-2008.....Standard Specification for Steel Castings,
Carbon, Suitable for Fusion Welding, for High
Temperature Service
- A285-01.....Pressure Vessel Plates, Carbon Steel, Low-and-
Intermediate-Tensile Strength
- A307-2007.....Carbon Steel Bolts and Studs, 60,000 PSI Tensile
Strength
- A516-2006.....Pressure Vessel Plates, Carbon Steel, for
Moderate-and- Lower Temperature Service
- A536-84(2004)e1.....Standard Specification for Ductile Iron Castings
- B32-2008.....Solder Metal
- B61-2008.....Steam or Valve Bronze Castings
- B62-2009.....Composition Bronze or Ounce Metal Castings
- B88-2003.....Seamless Copper Water Tube
- F439-06.....Socket-Type Chlorinated Poly (Vinyl Chloride)
(CPVC) Plastic Pipe Fittings, Schedule 80
- F441-02(2008).....Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic
Pipe, Schedules 40 and 80
- E. American Welding Society (AWS):
- A5.8-2004.....Filler Metals for Brazing and Braze Welding
- B2.1-00.....Welding Procedure and Performance Qualifications
- F. Manufacturers Standardization Society (MSS) of the Valve and Fitting
Industry, Inc.:
- SP-67-95.....Butterfly Valves
- SP-70-98.....Cast Iron Gate Valves, Flanged and Threaded Ends
- SP-71-97.....Gray Iron Swing Check Valves, Flanged and
Threaded Ends
- SP-72-99.....Ball Valves with Flanged or Butt-Welding Ends
for General Service
- SP-78-98.....Cast Iron Plug Valves, Flanged and Threaded Ends
- SP-80-97.....Bronze Gate, Globe, Angle and Check Valves
- SP-85-94.....Cast Iron Globe and Angle Valves, Flanged and
Threaded Ends

G. Military Specifications (Mil. Spec.):

MIL-S-901D-1989.....Shock Tests, H.I. (High Impact) Shipboard
Machinery, Equipment, and Systems

H. National Board of Boiler and Pressure Vessel Inspectors (NB): Relieving
Capacities of Safety Valves and Relief Valves

I. Tubular Exchanger Manufacturers Association: TEMA 18th Edition, 2000

PART 2 - PRODUCTS

2.1 PIPE AND EQUIPMENT SUPPORTS, PIPE SLEEVES, AND WALL AND CEILING PLATES

Provide in accordance with Section 23 05 11, COMMON WORK RESULTS FOR
HVAC AND STEAM GENERATION.

2.2 PIPE AND TUBING

A. Steam Piping: Steel, ASTM A53, Grade B, seamless or ERW; A106 Grade B,
Seamless; Schedule 40.

B. Steam Condensate and Pumped Condensate Piping:

1. Concealed above ceiling, in wall or chase: Copper water tube ASTM
B88, Type K, hard drawn.

2. All other locations: Copper water tube ASTM B88, Type K, hard drawn;
or steel, ASTM A53, Grade B, Seamless or ERW, or A106 Grade B
Seamless, Schedule 80.

C. Vent Piping: Steel, ASTM A53, Grade B, seamless or ERW; A106 Grade B,
Seamless; Schedule 40, galvanized.

2.3 FITTINGS FOR STEEL PIPE

A. 50 mm (2 inches) and Smaller: Screwed or welded.

1. Butt welding: ASME B16.9 with same wall thickness as connecting
piping.

2. Forged steel, socket welding or threaded: ASME B16.11.

3. Screwed: 150 pound malleable iron, ASME B16.3. 125 pound cast iron,
ASME B16.4, may be used in lieu of malleable iron, except for steam
and steam condensate piping. Provide 300 pound malleable iron, ASME
B16.3 for steam and steam condensate piping. Cast iron fittings or
piping is not acceptable for steam and steam condensate piping.
Bushing reduction of a single pipe size, or use of close nipples, is
not acceptable.

4. Unions: ASME B16.39.

5. Steam line drip station and strainer quick-couple blowdown hose
connection: Straight through, plug and socket, screw or cam locking
type for 15 mm (1/2 inch) ID hose. No integral shut-off is required.

- B. 65 mm (2-1/2 inches) and Larger: Welded or flanged joints.
 - 1. Butt welding fittings: ASME B16.9 with same wall thickness as connecting piping. Elbows shall be long radius type, unless otherwise noted.
 - 2. Welding flanges and bolting: ASME B16.5:
 - a. Steam service: Weld neck or slip-on, raised face, with non-asbestos gasket. Non-asbestos gasket shall either be stainless steel spiral wound strip with flexible graphite filler or compressed inorganic fiber with nitrile binder rated for saturated and superheated steam service 750 degrees F and 1500 psi.
 - b. Flange bolting: Carbon steel machine bolts or studs and nuts, ASTM A307, Grade B.
- C. Welded Branch and Tap Connections: Forged steel weldolets, or branchlets and threadolets may be used for branch connections up to one pipe size smaller than the main. Forged steel half-couplings, ASME B16.11 may be used for drain, vent and gage connections.

2.4 FITTINGS FOR COPPER TUBING

- A. Solder Joint:
 - 1. Joints shall be made up in accordance with recommended practices of the materials applied. Apply 95/5 tin and antimony on all copper piping.
- B. Bronze Flanges and Flanged Fittings: ASME B16.24.
- C. Fittings: ANSI/ASME B16.18 cast copper or ANSI/ASME B16.22 solder wrought copper.

2.5 DIELECTRIC FITTINGS

- A. Provide where copper tubing and ferrous metal pipe are joined.
- B. 50 mm (2 inches) and Smaller: Threaded dielectric union, ASME B16.39.
- C. 65 mm (2 1/2 inches) and Larger: Flange union with dielectric gasket and bolt sleeves, ASME B16.42.
- D. Temperature Rating, 121 degrees C (250 degrees F) for steam condensate and as required for steam service.

2.6 SCREWED JOINTS

- A. Pipe Thread: ANSI B1.20.
- B. Lubricant or Sealant: Oil and graphite or other compound approved for the intended service.

2.7 VALVES

- A. Asbestos packing is not acceptable.
- B. All valves of the same type shall be products of a single manufacturer.

C. Provide chain operators for valves 150 mm (6 inches) and larger when the centerline is located 2100 mm (7 feet) or more above the floor or operating platform.

D. Shut-Off Valves

1. Gate Valves:

- a. 50 mm (2 inches) and smaller: MSS-SP80, Bronze, 1034 kPa (150 lb.), wedge disc, rising stem, union bonnet.
- b. 65 mm (2 1/2 inches) and larger: Flanged, outside screw and yoke.
 - 1) High pressure steam 413 kPa (60 psig) and above nominal MPS system): Cast steel body, ASTM A216 grade WCB, 1034 kPa (150 psig) at 260 degrees C (500 degrees F), 11-1/2 to 13 percent chrome stainless steel solid disc and seats. Provide 25 mm (1 inch) factory installed bypass with globe valve on valves 100 mm (4 inches) and larger.
 - 2) All other services: MSS-SP 70, iron body, bronze mounted, 861 kPa (125 psig) wedge disc.

E. Globe and Angle Valves:

1. Globe Valves:

- a. 50 mm (2 inches) and smaller: MSS-SP 80, bronze, 1034 kPa (150 lb.) Globe valves shall be union bonnet with metal plug type disc.
- b. 65 mm (2 1/2 inches) and larger:
 - 1) Globe valves for high pressure steam 413 kPa (60 psig) and above nominal MPS system): Cast steel body, ASTM A216 grade WCB, flanged, OS&Y, 1034 kPa (150 psig) at 260 degrees C (500 degrees F), 11-1/2 to 13 percent chrome stainless steel disc and renewable seat rings.
 - 2) All other services: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS-SP-85 for globe valves.

2. Angle Valves

- a. 50 mm (2 inches) and smaller: MSS-SP 80, bronze, 1034 kPa (150 lb.) Angle valves shall be union bonnet with metal plug type disc.
- b. 65 mm (2 1/2 inches) and larger:
 - 1) Angle valves for high pressure steam 413 kPa (60 psig) and above nominal MPS system): Cast steel body, ASTM A216 grade WCB, flanged, OS&Y, 1034 kPa (150 psig) at 260 degrees C (500 degrees F), 11-1/2 to 13 percent chrome stainless steel disc and renewable seat rings.
 - 2) All other services: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS-SP-85 for angle valves.

F. Swing Check Valves

1. 50 mm (2 inches) and smaller: MSS-SP 80, bronze, 1034 kPa (150 psig), 45 degree swing disc.
2. 65 mm (2-1/2 inches) and Larger:
 - a. Check valves for high pressure steam 413 kPa (60 psig) and above nominal MPS system: Cast steel body, ASTM A216 grade WCB, flanged, OS&Y, 1034 kPa (150 psig) at 260 degrees C (500 degrees F), 11-1/2 to 13 percent chrome stainless steel disc and renewable seat rings.
 - b. All other services: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS-SP-71 for check valves.

G. Manual Radiator/Convactor Valves: Brass, packless, with position indicator.

2.8 STRAINERS

- A. Basket or Y Type. Tee type is acceptable for gravity flow and pumped steam condensate service.
- B. All Other Services: Rated 861 kPa (125 psig) saturated steam.
 1. 50 mm (2 inches) and smaller: Cast iron or bronze.
 2. 65 mm (2-1/2 inches) and larger: Flanged, iron body.
- C. Screens: Bronze, monel metal or 18-8 stainless steel, free area not less than 2-1/2 times pipe area, with perforations as follows:
 1. 75 mm (3 inches) and smaller: 20 mesh for steam and 1.1 mm (0.045 inch) diameter perforations for liquids.
 2. 100 mm (4 inches) and larger: 1.1 mm (0.045) inch diameter perforations for steam and 3.2 mm (0.125 inch) diameter perforations for liquids.

2.9 PIPE ALIGNMENT

Guides: Provide factory-built guides along the pipe line to permit axial movement only and to restrain lateral and angular movement. Guides must be designed to withstand a minimum of 15 percent of the axial force which will be imposed on the expansion joints and anchors. Field-built guides may be used if detailed on the contract drawings.

2.10 EXPANSION JOINTS

- A. Factory built devices, inserted in the pipe lines, designed to absorb axial cyclical pipe movement which results from thermal expansion and contraction. This includes factory-built or field-fabricated guides located along the pipe lines to restrain lateral pipe motion and direct the axial pipe movement into the expansion joints.
- B. Minimum Service Requirements:
 1. Pressure Containment:

- a. Steam Service 35-200 kPa (5-30 psig): Rated 345 kPa (50 psig) at 148 degrees C (298 degrees F).
 - b. Steam Service 214-850 kPa (31-125 psig): Rated 1025 kPa (150 psig) at 186 degrees C (366 degrees F).
 - c. Steam Service 869-1025 kPa (126-150 psig): Rated 1375 kPa (200 psig) at 194 degrees C (382 degrees F).
 - d. Condensate Service: Rated 690 kPa (100 psig) at 154 degrees C (310 degrees F).
- 2. Number of Full Reverse Cycles without failure: Minimum 1000.
- 3. Movement: As shown on drawings plus recommended safety factor of manufacturer.
- C. Manufacturing Quality Assurance: Conform to Expansion Joints Manufacturers Association Standards.
- D. Bellows - Internally Pressurized Type:
 - 1. Multiple corrugations of Type 304 or Type A240-321 stainless steel.
 - 2. Internal stainless steel sleeve entire length of bellows.
 - 3. External cast iron equalizing rings for services exceeding 340 kPa (50 psig).
 - 4. Welded ends.
 - 5. Design shall conform to standards of EJMA and ASME B31.1.
 - 6. External tie rods designed to withstand pressure thrust force upon anchor failure if one or both anchors for the joint are at change in direction of pipeline.
 - 7. Integral external cover.
- E. Bellows - Externally Pressurized Type:
 - 1. Multiple corrugations of Type 304 stainless steel.
 - 2. Internal and external guide integral with joint.
 - 3. Design for external pressurization of bellows to eliminate squirm.
 - 4. Welded ends.
 - 5. Conform to the standards of EJMA and ASME B31.1.
 - 6. Threaded connection at bottom, 25 mm (one inch) minimum, for drain or drip point.
 - 7. Integral external cover and internal sleeve.
- F. Expansion Joint Identification: Provide stamped brass or stainless steel nameplate on each expansion joint listing the manufacturer, the allowable movement, flow direction, design pressure and temperature, date of manufacture, and identifying the expansion joint by the identification number on the contract drawings.

2.11 FLEXIBLE BALL JOINTS

- A. Design and Fabrication: One piece component construction, fabricated from steel with welded ends, designed for a working steam pressure of 1720 kPa (250 psig) and a temperature of 232 degrees C (450 degrees F). Each joint shall provide for 360 degrees rotation in addition to a minimum angular flexible movement of 30 degrees for sizes 6 mm (1/4 inch) to 150 mm (6 inch) inclusive, and 15 degrees for sizes 65 mm (2-1/2 inches) to 750 mm (30 inches). Joints through 350 mm (14 inches) shall have forged pressure retaining members; while size 400 mm (16 inches) through 760 mm (30 inches) shall be of one piece construction.
- B. Material:
 - 1. Cast or forged steel pressure containing parts and bolting in accordance with Section II of the ASME Boiler Code or ASME B31.1. Retainer may be ductile iron ASTM A536, Grade 65-45-12, or ASME Section II SA 515, Grade 70.
 - 2. Gaskets: Steam pressure molded composition design for a temperature range of from minus 10 degrees C (50 degrees F) to plus 274 degrees C (525 degrees F).
- C. Certificates: Submit qualifications of ball joints in accordance with the following test data:
 - 1. Low pressure leakage test: 41 kPa (6psig) saturated steam for 60 days.
 - 2. Flex cycling: 800 Flex cycles at 3445 kPa (500 psig) saturated steam.
 - 3. Thermal cycling: 100 saturated steam pressure cycles from atmospheric pressure to operating pressure and back to atmospheric pressure.
 - 4. Environmental shock tests: Forward certificate from a recognized test laboratory, that ball joints of the type submitted has passed shock testing in accordance with Mil. Spec MIL-S-901.
 - 5. Vibration: 170 hours on each of three mutually perpendicular axis at 25 to 125 Hz; 1.3 mm to 2.5 mm (0.05 inch to 0.1 inch) double amplitude on a single ball joint and 3 ball joint off set.

2.12 STEAM SYSTEM COMPONENTS

- A. Safety Valves and Accessories: Comply with ASME Boiler and Pressure Vessel Code, Section VIII. Capacities shall be certified by National Board of Boiler and Pressure Vessel Inspectors, maximum accumulation 10 percent. Provide lifting lever. Provide drip pan elbow where shown.
- B. Steam PRV for Individual Equipment: Cast iron or bronze body, screwed or flanged ends, rated 861 kPa (125 psig) working pressure. Single-seated, diaphragm operated, spring loaded, adjustable range, all parts renewable.

- C. Steam Trap: Each type of trap shall be the product of a single manufacturer. Provide trap sets at all low points and at 61 m (200 feet) intervals on the horizontal main lines.
1. Floats and linkages shall provide sufficient force to open trap valve over full operating pressure range available to the system. Unless otherwise indicated on the drawings, traps shall be sized for capacities indicated at minimum pressure drop as follows:
 - a. For equipment with modulating control valve: 1.7 kPa (1/4 psig), based on a condensate leg of 300 mm (12 inches) at the trap inlet and gravity flow to the receiver.
 - b. For main line drip trap sets and other trap sets at steam pressure: Up to 70 percent of design differential pressure. Condensate may be lifted to the return line.
 2. Trap bodies: Bronze, cast iron, or semi-steel, constructed to permit ease of removal and servicing working parts without disturbing connecting piping. For systems without relief valve traps shall be 5.
 3. Mechanism: Brass, stainless steel or corrosion resistant alloy. Rated for the pressure upstream of the PRV supplying the system.
 4. Balanced pressure thermostatic elements: Phosphor bronze, stainless steel or monel metal.
 5. Valves and seats: Suitable hardened corrosion resistant alloy.
 6. Floats: Stainless steel.
 7. Inverted bucket traps: Provide bi-metallic thermostatic element for rapid release of non-condensables.
- D. Thermostatic Air Vent (Steam): Brass or iron body, balanced pressure bellows, stainless steel (renewable) valve and seat, rated 861 kPa (125 psig) working pressure, 20 mm (3/4 inch) screwed connections. Air vents shall be balanced pressure type that responds to steam pressure-temperature curve and vents air at any pressure.

2.13 GAGES, PRESSURE AND COMPOUND

- A. ASME B40.1, Accuracy Grade 1A, (pressure, vacuum, or compound), initial mid-scale accuracy 1 percent of scale (Qualify grade), metal or phenolic case, 115 mm (4-1/2 inches) in diameter, 6 mm (1/4 inch) NPT bottom connection, white dial with black graduations and pointer, clear glass or acrylic plastic window, suitable for board mounting. Provide red "set hand" to indicate normal working pressure.
- B. Provide brass, lever handle union cock. Provide brass/bronze pressure snubber for gages in water service. Provide brass pigtail syphon for steam gages.

- C. Range of Gages: For services not listed provide range equal to at least 130 percent of normal operating range:

Low pressure steam and steam condensate to 103 kPa(15 psig)	0 to 207 kPa (30 psig).
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2.14 PRESSURE/TEMPERATURE TEST PROVISIONS

- A. Provide one each of the following test items to the Contracting Officer Technical Representative:
1. 6 mm (1/4 inch) FPT by 3 mm (1/8 inch) diameter stainless steel pressure gage adapter probe for extra long test plug. PETE'S 500 XL is an example.
 2. 90 mm (3-1/2 inch) diameter, one percent accuracy, compound gage, 762 mm (30 inches) Hg to 689 kPa (100 psig) range.
 3. 0 - 104 degrees C (32-220 degrees F) pocket thermometer one-half degree accuracy, 25 mm (one inch) dial, 125 mm (5 inch) long stainless steel stem, plastic case.

2.15 FIRESTOPPING MATERIAL

Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

PART 3 - EXECUTION

3.1 GENERAL

- A. The drawings show the general arrangement of pipe and equipment but do not show all required fittings and offsets that may be necessary to connect pipes to equipment, fan-coils, coils, radiators, etc., and to coordinate with other trades. Provide all necessary fittings, offsets and pipe runs based on field measurements and at no additional cost to the government. Coordinate with other trades for space available and relative location of HVAC equipment and accessories to be connected on ceiling grid. Pipe location on the drawings shall be altered by contractor where necessary to avoid interferences and clearance difficulties.
- B. Store materials to avoid excessive exposure to weather or foreign materials. Keep inside of piping relatively clean during installation and protect open ends when work is not in progress.
- C. Support piping securely. Refer to PART 3, Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION. Install convertors and other heat exchangers at height sufficient to provide gravity flow of condensate to the flash tank and condensate pump.

- D. Install piping generally parallel to walls and column center lines, unless shown otherwise on the drawings. Space piping, including insulation, to provide 25 mm (one inch) minimum clearance between adjacent piping or other surface. Unless shown otherwise, slope steam, condensate and drain piping down in the direction of flow not less than 25 mm (one inch) in 12 m (40 feet). Provide eccentric reducers to keep bottom of sloped piping flat.
- E. Locate and orient valves to permit proper operation and access for maintenance of packing, seat and disc. Generally locate valve stems in overhead piping in horizontal position. Provide a union adjacent to one end of all threaded end valves. Control valves usually require reducers to connect to pipe sizes shown on the drawing. Install butterfly valves with the valve open as recommended by the manufacturer to prevent binding of the disc in the seat.
- F. Offset equipment connections to allow valving off for maintenance and repair with minimal removal of piping. Provide flexibility in equipment connections and branch line take-offs with 3-elbow swing joints where noted on the drawings.
- G. Tee water piping runouts or branches into the side of mains or other branches. Avoid bull-head tees, which are two return lines entering opposite ends of a tee and exiting out the common side.
- H. Connect piping to equipment as shown on the drawings. Install components furnished by others such as:
 - 1. Flow elements (orifice unions), control valve bodies, flow switches, pressure taps with valve, and wells for sensors.
- I. Firestopping: Fill openings around uninsulated piping penetrating floors or fire walls, with firestop material. For firestopping insulated piping refer to Section 23 07 11, HVAC, PLUMBING, and BOILER PLANT INSULATION.
- J. Where copper piping is connected to steel piping, provide dielectric connections.
- K. Pipe vents to the exterior. Where a combined vent is provided, the cross sectional area of the combined vent shall be equal to sum of individual vent areas. Slope vent piping one inch in 40 feet (0.25 percent) in direction of flow. Provide a drip trap elbow on relief valve outlets if the vent rises to prevent backpressure. Terminate vent minimum 0.3 M (12 inches) above the roof or through the wall minimum 2.5 M (8 feet) above grade with down turned elbow.

3.2 PIPE JOINTS

- A. Welded: Beveling, spacing and other details shall conform to ASME B31.1 and AWS B2.1. See Welder's qualification requirements under "Quality Assurance" in Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- B. Screwed: Threads shall conform to ASME B1.20; joint compound shall be applied to male threads only and joints made up so no more than three threads show. Coat exposed threads on steel pipe with joint compound, or red lead paint for corrosion protection.
- C. 125 Pound Cast Iron Flange (Plain Face): Mating flange shall have raised face, if any, removed to avoid overstressing the cast iron flange.

3.3 STEAM TRAP PIPING

Install to permit gravity flow to the trap. Provide gravity flow (avoid lifting condensate) from the trap where modulating control valves are used. Support traps weighing over 11 kg (25 pounds) independently of connecting piping.

3.4 LEAK TESTING

- A. Inspect all joints and connections for leaks and workmanship and make corrections as necessary, to the satisfaction of the Contracting Officer Technical Representative in accordance with the specified requirements. Testing shall be performed in accordance with the specification requirements.
- B. An operating test at design pressure, and for hot systems, design maximum temperature.
- C. A hydrostatic test at 1.5 times design pressure. For water systems the design maximum pressure would usually be the static head, or expansion tank maximum pressure, plus pump head. Factory tested equipment (convertors, exchangers, coils, etc.) need not be field tested. Avoid excessive pressure on mechanical seals and safety devices.

3.5 FLUSHING AND CLEANING PIPING SYSTEMS

Steam, Condensate and Vent Piping: No flushing or chemical cleaning required. Accomplish cleaning by pulling all strainer screens and cleaning all scale/dirt legs during start-up operation.

3.6 OPERATING AND PERFORMANCE TEST AND INSTRUCTION

- A. Refer to PART 3, Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- B. Adjust red set hand on pressure gages to normal working pressure.

- - - E N D - - -

SECTION 23 23 00
REFRIGERANT PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Field refrigerant piping and associated drain and condenser water piping for walk-in coolers and freezers, including required pipe insulation.
- B. Refrigerant piping shall be sized, selected, and designed either by the equipment manufacturer or in strict accordance with the manufacturer's published instructions. The schematic piping diagram shall show all accessories such as, stop valves, level indicators, liquid receivers, oil separator, gauges, thermostatic expansion valves, solenoid valves, moisture separators and driers to make a complete installation.
- C. Definitions:
 - 1. Refrigerating system: Combination of interconnected refrigerant-containing parts constituting one closed refrigeration circuit in which a refrigerant is circulated for the purpose of extracting heat.
 - a. Low side means the parts of a refrigerating system subjected to evaporator pressure.
 - b. High side means the parts of a refrigerating system subjected to condenser pressure.
 - 2. Brazed joint: A gas-tight joint obtained by the joining of metal parts with alloys which melt at temperatures higher than 449 degrees C (840 degrees F) but less than the melting temperatures of the joined parts.

1.2 RELATED WORK

- A. Section 11 41 21, WALK-IN COOLERS and FREEZERS: Piping requirements for freezers and refrigerators.
- B. Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION: General mechanical requirements and items, which are common to more than one section of Division 23.
- C. Section 23 07 11, HVAC, PLUMBING, and BOILER PLANT INSULATION: Requirements for piping insulation.

1.3 QUALITY ASSURANCE

- A. Refer to specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

- B. Comply with ASHRAE Standard 15, Safety Code for Mechanical Refrigeration. The application of this Code is intended to assure the safe design, construction, installation, operation, and inspection of every refrigerating system employing a fluid which normally is vaporized and liquefied in its refrigerating cycle.
- C. Comply with ASME B31.5: Refrigerant Piping and Heat Transfer Components.
- D. Products shall comply with UL 207 "Refrigerant-Containing Components and Accessories, "Nonelectrical"; or UL 429 "Electrical Operated Valves."

1.4 SUBMITTALS

- A. Submit in accordance with specification Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Shop Drawings:
 - 1. Complete information for components noted, including valves and refrigerant piping accessories, clearly presented, shall be included to determine compliance with drawings and specifications for components noted below:
 - a. Tubing and fittings
 - b. Valves
 - c. Strainers
 - d. Moisture-liquid indicators
 - e. Filter-driers
 - f. Flexible metal hose
 - g. Liquid-suction interchanges
 - h. Oil separators (when specified)
 - i. Gages
 - j. Pipe and equipment supports
 - k. Refrigerant and oil
 - l. Pipe/conduit roof penetration cover
 - m. Soldering and brazing materials
 - 2. Layout of refrigerant piping and accessories, including flow capacities, valves locations, and oil traps slopes of horizontal runs, floor/wall penetrations, and equipment connection details.
- C. Certification: Copies of certificates for welding procedure, performance qualification record and list of welders' names and symbols.
- D. Design Manual: Furnish two copies of design manual of refrigerant valves and accessories.

1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

- B. Air Conditioning, Heating, and Refrigeration Institute (ARI/AHRI):
- 495-1999 (R2002).....Standard for Refrigerant Liquid Receivers
 - 730-2005.....Flow Capacity Rating of Suction-Line Filters and
Suction-Line Filter-Driers
 - 750-2007.....Thermostatic Refrigerant Expansion Valves
 - 760-2007.....Performance Rating of Solenoid Valves for Use
with Volatile Refrigerants
- C. American Society of Heating Refrigerating and Air Conditioning Engineers (ASHRAE):
- ANSI/ASHRAE 15-2007.....Safety Standard for Refrigeration Systems (ANSI)
 - ANSI/ASHRAE 17-2008.....Method of Testing Capacity of Thermostatic
Refrigerant Expansion Valves (ANSI)
 - 63.1-95 (RA 01).....Method of Testing Liquid Line Refrigerant Driers
(ANSI)
- D. American National Standards Institute (ANSI):
- ASME (ANSI)A13.1-2007...Scheme for Identification of Piping Systems
 - Z535.1-2006.....Safety Color Code
- E. American Society of Mechanical Engineers (ASME):
- ANSI/ASME B16.22-2001 (R2005)
 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings (ANSI)
 - ANSI/ASME B16.24-2006 Cast Copper Alloy Pipe Flanges and Flanged
Fittings, Class 150, 300, 400, 600, 900, 1500 and 2500 (ANSI)
 - ANSI/ASME B31.5-2006....Refrigeration Piping and Heat Transfer
Components (ANSI)
 - ANSI/ASME B40.100-2005..Pressure Gauges and Gauge Attachments
 - ANSI/ASME B40.200-2008..Thermometers, Direct Reading and Remote Reading
- F. American Society for Testing and Materials (ASTM)
- A126-04.....Standard Specification for Gray Iron Castings
for Valves, Flanges, and Pipe FittingsB32-08
Standard Specification for Solder Metal
 - B88-03.....Standard Specification for Seamless Copper Water
Tube
 - B88M-05.....Standard Specification for Seamless Copper Water
Tube (Metric)
 - B280-08.....Standard Specification for Seamless Copper Tube
for Air Conditioning and Refrigeration Field
Service

G. American Welding Society, Inc. (AWS):

Brazing Handbook

A5.8/A5.8M-04.....Standard Specification for Filler Metals for
Brazing and Braze Welding

H. Federal Specifications (Fed. Spec.)

Fed. Spec. GG

I. Underwriters Laboratories (U.L.):

UL 207-2009.....Standard for Refrigerant-Containing Components
and Accessories, Nonelectrical

UL 429-99 (Rev.2006)....Standard for Electrically Operated Valves

PART 2 - PRODUCTS**2.1 PIPING AND FITTINGS**

- A. Refrigerant Piping: For piping up to 100 mm (4 inch) use Copper refrigerant tube, ASTM B280, cleaned, dehydrated and sealed, marked ACR on hard temper straight lengths. Coils shall be tagged ASTM B280 by the manufacturer. For piping over 100 mm (4 inch) use A53 Black SML steel.
- B. Fittings, Valves and Accessories:
 - 1. Copper fittings: Wrought copper fittings, ASME B16.22.
 - a. Brazed Joints, refrigerant tubing: Cadmium free, AWS A5.8/A5.8M, 45 percent silver brazing alloy, Class BAg-5.
 - b. Solder Joints, water and drain: 95-5 tin-antimony, ASTM B32 (95TA).
 - 2. Steel fittings: ASTM wrought steel fittings.
 - a. Refrigerant piping - Welded Joints.
 - 3. Flanges and flanged fittings: ASME B16.24.
 - 4. Refrigeration Valves:
 - a. Stop Valves: Brass or bronze alloy, packless, or packed type with gas tight cap, frost proof, back seating.
 - b. Pressure Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; UL listed. Forged brass with nonferrous, corrosion resistant internal working parts of high strength, cast iron bodies conforming to ASTM A126, Grade B. Set valves in accordance with ASHRAE Standard 15.
 - c. Solenoid Valves: Comply with ARI 760 and UL 429, UL-listed, two-position, direct acting or pilot-operated, moisture and vapor-proof type of corrosion resisting materials, designed for intended service, and solder-end connections. Fitted with suitable NEMA 250 enclosure of type required by location and normally open.

- d. Thermostatic Expansion Valves: Comply with ARI 750. Brass body with stainless-steel or non-corrosive non ferrous internal parts, diaphragm and spring-loaded (direct-operated) type with sensing bulb and distributor having side connection for hot-gas bypass and external equalizer. Size and operating characteristics as recommended by manufacturer of evaporator and factory set for superheat requirements. Solder-end connections. Testing and rating in accordance with ASHRAE Standard 17.
- e. Check Valves: Brass or bronze alloy with swing or lift type, with tight closing resilient seals for silent operation; designed for low pressure drop, and with solder-end connections. Direction of flow shall be legibly and permanently indicated on the valve body.
- 5. Strainers: Designed to permit removing screen without removing strainer from piping system, and provided with screens 80 to 100 mesh in liquid lines DN 25 (NPS 1) and smaller, 60 mesh in liquid lines larger than DN 25 (NPS 1), and 40 mesh in suction lines. Provide strainers in liquid line serving each thermostatic expansion valve, and in suction line serving each refrigerant compressor not equipped with integral strainer.
- 6. Refrigerant Moisture/Liquid Indicators: Double-ported type having heavy sight glasses sealed into forged bronze body and incorporating means of indicating refrigerant charge and moisture indication. Provide screwed brass seal caps.
- 7. Refrigerant Filter-Dryers: UL listed, angle or in-line type, as shown on drawings. Conform to ARI Standard 730 and ASHRAE Standard 63.1. Heavy gage steel shell protected with corrosion-resistant paint; perforated baffle plates to prevent desiccant bypass. Size as recommended by manufacturer for service and capacity of system with connection not less than the line size in which installed. Filter driers with replaceable filters shall be furnished with one spare element of each type and size.
- 8. Flexible Metal Hose: Seamless bronze corrugated hose, covered with bronze wire braid, with standard copper tube ends. Provide in suction and discharge piping of each compressor.

2.2 GAGES

- A. Temperature Gages: Comply with ASME B40.200. Industrial-duty type and in required temperature range for service in which installed. Gages shall have Celsius scale in 1-degree (Fahrenheit scale in 2-degree) graduations and with black number on a white face. The pointer shall be adjustable. Rigid stem type temperature gages shall be provided in

thermal wells located within 1525 mm (5 feet) of the finished floor. Universal adjustable angle type or remote element type temperature gages shall be provided in thermal wells located 1525 to 2135 mm (5 to 7 feet) above the finished floor. Remote element type temperature gages shall be provided in thermal wells located 2135 mm (7 feet) above the finished floor.

- B. Vacuum and Pressure Gages: Comply with ASME B40.100 and provide with throttling type needle valve or a pulsation dampener and shut-off valve. Gage shall be a minimum of 90 mm (3-1/2 inches) in diameter with a range from 0 kPa (0 psig) to approximately 1.5 times the maximum system working pressure. Each gage range shall be selected so that at normal operating pressure, the needle is within the middle-third of the range.
 - 1. Suction: 101 kPa (30 inches Hg) vacuum to 1723 kPa (gage) (250 psig).
 - 2. Discharge: 0 to 3445 kPa (gage) (0 to 500 psig).

2.3 THERMOMETERS AND WELLS

Refer to specification Section 23 21 13, HYDRONIC PIPING.

2.4 PIPE SUPPORTS

Refer to specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

2.5 ELECTRICAL HEAT TRACING SYSTEM

Refer to specification Section 23 21 13, HYDRONIC PIPING. Provide for freezer unit cooler drain piping.

2.6 REFRIGERANTS AND OIL

Provide EPA approved refrigerant and oil for proper system operation.

2.7 PIPE/CONDUIT ROOF PENETRATION COVER

- A. Prefabricated Roof Curb: Galvanized steel or extruded aluminum 300 mm (12 inches) overall height, continuous welded corner seams, treated wood nailer, 38 mm (1-1/2 inch) thick, 48 kg/cu.m (3 lb/cu.ft.) density rigid mineral fiberboard insulation with metal liner, built-in cant strip (except for gypsum or tectum decks). For surface insulated roof deck, provide raised cant strip (recessed mounting flange) to start at the upper surface of the insulation. Curbs shall be constructed for pitched roof or ridge mounting as required to keep top of curb level.
- B. Penetration Cover: Galvanized sheet metal with flanged removable top. Provide 38 mm (1-1/2 inch) thick mineral fiber board insulation.
- C. Flashing Sleeves: Provide sheet metal sleeves for conduit and pipe penetrations of the penetration cover. Seal watertight penetrations.

2.8 PIPE INSULATION FOR WALK-IN COOLERS AND FREEZERS AND LABORATORY REFRIGERATORS AND MORTUARY REFRIGERATORS

- A. Flexible elastomeric: Refer to specification Section 23 07 11, HVAC, PLUMBING, and BOILER PLANT INSULATION.
- B. Insulate refrigerant suction piping from unit cooler to condensing unit. Use 20 mm (3/4-inch) thick insulation on piping inside the refrigerator or freezer and 40 mm (1-1/2 inch) thick insulation (double layer required) on piping outside the refrigerated space.
- C. Insulate unit cooler drain piping in freezer units, over electric heat tracing system, to prevent drain from freezing during defrost.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install refrigerant piping and refrigerant containing parts in accordance with ASHRAE Standard 15 and ASME B31.5
 - 1. Install piping as short as possible, with a minimum number of joints, elbow and fittings.
 - 2. Install piping with adequate clearance between pipe and adjacent walls and hangers to allow for service and inspection. Space piping, including insulation, to provide 25 mm (1 inch) minimum clearance between adjacent piping or other surface. Use pipe sleeves through walls, floors, and ceilings, sized to permit installation of pipes with full thickness insulation.
 - 3. Locate and orient valves to permit proper operation and access for maintenance of packing, seat and disc. Generally locate valve stems in overhead piping in horizontal position. Provide a union adjacent to one end of all threaded end valves. Control valves usually require reducers to connect to pipe sizes shown on the drawing.
 - 4. Use copper tubing in protective conduit when installed below ground.
 - 5. Install hangers and supports per ASME B31.5 and the refrigerant piping manufacturer's recommendations.
- B. Joint Construction:
 - 1. Brazed Joints: Comply with AWS "Brazing Handbook" and with filler materials complying with AWS A5.8/A5.8M.
 - a. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper tubing.
 - b. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.
 - c. Swab fittings and valves with manufacturer's recommended cleaning fluid to remove oil and other compounds prior to installation.

- d. Pass nitrogen gas through the pipe or tubing to prevent oxidation as each joint is brazed. Cap the system with a reusable plug after each brazing operation to retain the nitrogen and prevent entrance of air and moisture.
- C. Protect refrigerant system during construction against entrance of foreign matter, dirt and moisture; have open ends of piping and connections to compressors, condensers, evaporators and other equipment tightly capped until assembly.
- D. Pipe relief valve discharge to outdoors for systems containing more than 45 kg (100 lbs) of refrigerant.
- E. Firestopping: Fill openings around uninsulated piping penetrating floors or fire walls, with firestop material. For firestopping insulated piping refer to Section 23 07 11, HVAC, PLUMBING, and BOILER PLANT INSULATION.

3.2 PIPE AND TUBING INSULATION

- A. Refer to specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- B. Apply two coats of weather-resistant finish as recommended by the manufacturer to insulation exposed to outdoor weather.

3.3 SIGNS AND IDENTIFICATION

- A. Each refrigerating system erected on the premises shall be provided with an easily legible permanent sign securely attached and easily accessible, indicating thereon the name and address of the installer, the kind and total number of pounds of refrigerant required in the system for normal operations, and the field test pressure applied.
- B. Systems containing more than 50 kg (110 lb) of refrigerant shall be provided with durable signs, in accordance with ANSI A13.1 and ANSI Z535.1, having letters not less than 13 mm (1/2 inch) in height designating:
 - 1. Valves and switches for controlling refrigerant flow, the ventilation and the refrigerant compressor(s).
 - 2. Signs on all exposed high pressure and low pressure piping installed outside the machinery room, with name of the refrigerant and the letters "HP" or "LP."

3.4 FIELD QUALITY CONTROL

- A. Prior to initial operation examine and inspect piping system for conformance to plans and specifications and ASME B31.5. Correct equipment, material, or work rejected because of defects or nonconformance with plans and specifications, and ANSI codes for pressure piping.

- B. After completion of piping installation and prior to initial operation, conduct test on piping system according to ASME B31.5. Furnish materials and equipment required for tests. Perform tests in the presence of Contracting Officer Technical Representative. If the test fails, correct defects and perform the test again until it is satisfactorily done and all joints are proved tight.
1. Every refrigerant-containing parts of the system that is erected on the premises, except compressors, condensers, evaporators, safety devices, pressure gages, control mechanisms and systems that are factory tested, shall be tested and proved tight after complete installation, and before operation.
 2. The high and low side of each system shall be tested and proved tight at not less than the lower of the design pressure or the setting of the pressure-relief device protecting the high or low side of the system, respectively, except systems erected on the premises using non-toxic and non-flammable Group A1 refrigerants with copper tubing not exceeding DN 18 (NPS 5/8). This may be tested by means of the refrigerant charged into the system at the saturated vapor pressure of the refrigerant at 20 degrees C (68 degrees F) minimum.
- C. Test Medium: A suitable dry gas such as nitrogen or shall be used for pressure testing. The means used to build up test pressure shall have either a pressure-limiting device or pressure-reducing device with a pressure-relief device and a gage on the outlet side. The pressure relief device shall be set above the test pressure but low enough to prevent permanent deformation of the system components.
- D. Refrigerator/Freezer Start-up and Performance Tests: Specification Section 11 41 21, WALK-IN COOLERS and FREEZERS.

3.5 SYSTEM TEST AND CHARGING

- A. System Test and Charging: As recommended by the equipment manufacturer or as follows:
1. Connect a drum of refrigerant to charging connection and introduce enough refrigerant into system to raise the pressure to 70 kPa (10 psi) gage. Close valves and disconnect refrigerant drum. Test system for leaks with halide test torch or other approved method suitable for the test gas used. Repair all leaking joints and retest.
 2. Connect a drum of dry nitrogen to charging valve and bring test pressure to design pressure for low side and for high side. Test entire system again for leaks.

3. Evacuate the entire refrigerant system by the triplicate evacuation method with a vacuum pump equipped with an electronic gage reading in mPa (microns). Pull the system down to 665 mPa (500 microns) 665 mPa (2245.6 inches of mercury at 60 degrees F) and hold for four hours then break the vacuum with dry nitrogen (or refrigerant). Repeat the evacuation two more times breaking the third vacuum with the refrigeration to be charged and charge with the proper volume of refrigerant.

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**SECTION 23 25 00
HVAC WATER TREATMENT**

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies cleaning and treatment of circulating HVAC water systems, including the following.

1. Cleaning compounds.

1.2 RELATED WORK

- A. Test requirements and instructions on use of equipment/system: Section 01 00 00, GENERAL REQUIREMENTS.
- B. General mechanical requirements and items, which are common to more than one section of Division 23: Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- C. Piping and valves: Section 23 21 13, HYDRONIC PIPING and Section 23 22 13, STEAM and CONDENSATE HEATING PIPING.

1.3 QUALITY ASSURANCE

- A. Refer to paragraph, QUALITY ASSURANCE in Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- B. Chemicals: Chemicals shall be non-toxic approved by local authorities and meeting applicable EPA requirements.

1.4 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data including:
1. Cleaning compounds and recommended procedures for their use.
- C. Water analysis verification.
- D. Materials Safety Data Sheet for all proposed chemical compounds, based on U.S. Department of Labor Form No. L5B-005-4.
- E. Maintenance and operating instructions in accordance with Section 01 00 00, GENERAL REQUIREMENTS.

PART 2 - PRODUCTS

2.1 CLEANING COMPOUNDS

- A. Alkaline phosphate or non-phosphate detergent/surfactant/specific to remove organic soil, hydrocarbons, flux, pipe mill varnish, pipe compounds, iron oxide, and like deleterious substances, with or without inhibitor, suitable for system wetted metals without deleterious effects.
- B. All chemicals to be acceptable for discharge to sanitary sewer.

- C. Refer to Section 23 21 13, HYDRONIC PIPING and Section 23 22 13, STEAM and CONDENSATE HEATING PIPING, PART 3, for flushing and cleaning procedures.

2.2 EQUIPMENT AND MATERIALS IDENTIFICATION

Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Before adding cleaning chemical to the closed system, all air handling coils and fan coil units should be isolated by closing the inlet and outlet valves and opening the bypass valves. This is done to prevent dirt and solids from lodging the coils.
- B. Do not valve in or operate system pumps until after system has been cleaned.
- C. After chemical cleaning is satisfactorily completed, open the inlet and outlet valves to each coil and close the by-pass valves. Also, clean all strainers.
- D. Perform tests and report results in accordance with Section 01 00 00, GENERAL REQUIREMENTS.
- E. Instruct VAMC personnel in system maintenance and operation in accordance with Section 01 00 00, GENERAL REQUIREMENTS.

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**SECTION 23 31 00
HVAC DUCTS AND CASINGS**

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Ductwork and accessories for HVAC including the following:
 - 1. Supply air, return air, outside air, exhaust, make-up air, and relief systems.
 - 2. Exhaust duct for kitchen hood exhaust (grease) and "wet exhaust" ducts.
- B. Definitions:
 - 1. SMACNA Standards as used in this specification means the HVAC Duct Construction Standards, Metal and Flexible.
 - 2. Seal or Sealing: Use of liquid or mastic sealant, with or without compatible tape overlay, or gasketing of flanged joints, to keep air leakage at duct joints, seams and connections to an acceptable minimum.
 - 3. Duct Pressure Classification: SMACNA HVAC Duct Construction Standards, Metal and Flexible.
 - 4. Exposed Duct: Exposed to view in a finished room.

1.2 RELATED WORK

- A. Fire Stopping Material: Section 07 84 00, FIRESTOPPING.
- B. Outdoor and Exhaust Louvers: Section 08 90 00, LOUVERS and VENTS.
- C. Kitchen Hoods: Section 23 38 13, COMMERCIAL-KITCHEN HOODS.
- D. General Mechanical Requirements: Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- E. Noise Level Requirements: Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.
- F. Duct Insulation: Section 23 07 11, HVAC, PLUMBING, and BOILER PLANT INSULATION
- G. Air Flow Control Valves and Terminal Units: Section 23 36 00, AIR TERMINAL UNITS.
- H. Supply Air Fans: Section 23 73 00, INDOOR CENTRAL-STATION AIR-HANDLING UNITS.
- I. Return Air and Exhaust Air Fans: Section 23 34 00, HVAC FANS.
- J. Air Filters and Filters' Efficiencies: Section 23 40 00, HVAC AIR CLEANING DEVICES.
- K. Duct Mounted Instrumentation: Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
- L. Testing and Balancing of Air Flows: Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC.

M. Smoke Detectors: Section 28 31 00, FIRE DETECTION and ALARM.

1.3 QUALITY ASSURANCE

- A. Refer to article, QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- B. Fire Safety Code: Comply with NFPA 90A.
- C. Duct System Construction and Installation: Referenced SMACNA Standards are the minimum acceptable quality.
- D. Duct Sealing, Air Leakage Criteria, and Air Leakage Tests: Ducts shall be sealed as per duct sealing requirements of SMACNA HVAC Air Duct Leakage Test Manual for duct pressure classes shown on the drawings.
- E. Duct accessories exposed to the air stream, such as dampers of all types (except smoke dampers) and access openings, shall be of the same material as the duct or provide at least the same level of corrosion resistance.

1.4 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data:
 - 1. Rectangular ducts:
 - a. Schedules of duct systems, materials and selected SMACNA construction alternatives for joints, sealing, gage and reinforcement.
 - b. Duct liner.
 - c. Sealants and gaskets.
 - d. Access doors.
 - 2. Round and flat oval duct construction details:
 - a. Manufacturer's details for duct fittings.
 - b. Duct liner.
 - c. Sealants and gaskets.
 - d. Access sections.
 - e. Installation instructions.
 - 3. Volume dampers, back draft dampers.
 - 4. Upper hanger attachments.
 - 5. Fire dampers, fire doors, and smoke dampers with installation instructions.
 - 6. Flexible ducts and clamps, with manufacturer's installation instructions.
 - 7. Flexible connections.
 - 8. Instrument test fittings.

- C. Coordination Drawings: Refer to article, SUBMITTALS, in Section 23 05 11
COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society of Civil Engineers (ASCE):
ASCE7-05.....Minimum Design Loads for Buildings and Other Structures
- C. American Society for Testing and Materials (ASTM):
A167-99(2009).....Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
A653-09.....Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy coated (Galvannealed) by the Hot-Dip process
A1011-09a.....Standard Specification for Steel, Sheet and Strip, Hot rolled, Carbon, structural, High-Strength Low-Alloy, High Strength Low-Alloy with Improved Formability, and Ultra-High Strength
B209-07.....Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
C1071-05e1.....Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)
E84-09a.....Standard Test Method for Surface Burning Characteristics of Building Materials
- D. National Fire Protection Association (NFPA):
90A-09.....Standard for the Installation of Air Conditioning and Ventilating Systems
96-08.....Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations
- E. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
2nd Edition - 2005.....HVAC Duct Construction Standards, Metal and Flexible
1st Edition - 1985.....HVAC Air Duct Leakage Test Manual
6th Edition - 2003.....Fibrous Glass Duct Construction Standards

F. Underwriters Laboratories, Inc. (UL):

181-08.....Factory-Made Air Ducts and Air Connectors

555-06Standard for Fire Dampers

555S-06Standard for Smoke Dampers

PART 2 - PRODUCTS

2.1 DUCT MATERIALS AND SEALANTS

- A. General: Except for systems specified otherwise, construct ducts, casings, and accessories of galvanized sheet steel, ASTM A653, coating G90; or, aluminum sheet, ASTM B209, alloy 1100, 3003 or 5052.
- B. Specified Corrosion Resistant Systems: Stainless steel sheet, ASTM A167, Class 302 or 304, Condition A (annealed) Finish No. 4 for exposed ducts and Finish No. 2B for concealed duct or ducts located in mechanical rooms.
- C. Optional Duct Materials:
 - 1. Grease Duct: Double wall factory-built grease duct, UL labeled and complying with NFPA 96 may be furnished in lieu of specified materials for kitchen and grill hood exhaust duct. Installation and accessories shall comply with the manufacturers catalog data. Outer jacket of exposed ductwork shall be stainless steel. Square and rectangular duct shown on the drawings will have to be converted to equivalent round size.
- D. Joint Sealing: Refer to SMACNA HVAC Duct Construction Standards, paragraph S1.9.
 - 1. Sealant: Elastomeric compound, gun or brush grade, maximum 25 flame spread and 50 smoke developed (dry state) compounded specifically for sealing ductwork as recommended by the manufacturer. Generally provide liquid sealant, with or without compatible tape, for low clearance slip joints and heavy, permanently elastic, mastic type where clearances are larger. Oil base caulking and glazing compounds are not acceptable because they do not retain elasticity and bond.
 - 2. Tape: Use only tape specifically designated by the sealant manufacturer and apply only over wet sealant. Pressure sensitive tape shall not be used on bare metal or on dry sealant.
 - 3. Gaskets in Flanged Joints: Soft neoprene.
- E. Approved factory made joints may be used.

2.2 DUCT CONSTRUCTION AND INSTALLATION

- A. Regardless of the pressure classifications outlined in the SMACNA Standards, fabricate and seal the ductwork in accordance with the following pressure classifications:

B. Duct Pressure Classification:

- 0 to 50 mm (2 inch)
- > 50 mm to 75 mm (2 inch to 3 inch)
- > 75 mm to 100 mm (3 inch to 4 inch)

Show pressure classifications on the floor plans.

C. Seal Class: All ductwork shall receive Class A Seal

D. Wet Air Exhaust Ducts and Accessories: Ducts for dishwashers, scullery hood, cart washers, manual cart washers, cage washers, steam sterilizer hoods and orthotics hoods shall be 1.3 mm (18 gage) stainless steel made liquid tight with continuous external weld for all seams and joints. Provide neoprene gaskets at flanged connections. Where ducts are not self draining back to the equipment, provide low point drain pocket with copper drain pipe to sanitary sewer. Provide access door in side of duct at drain pockets.

E. Kitchen and Grill Hood (Ventilator) Exhaust Ducts: Comply with NFPA 96.

1. Material: 1.6 mm (16 gage) steel sheet (black iron), ASTM A1011, or 1.3 mm (18 gage) stainless steel. Use stainless steel for exposed duct in occupied areas. See Optional Duct Materials.
2. Construction: Liquid tight with continuous external weld for all seams and joints. Where ducts are not self draining back to the equipment, provide low point drain pocket with copper drain pipe to sanitary sewer. Provide access doors or panels for duct cleaning inside of horizontal duct at drain pockets, at 6 m (20 feet) intervals, and at each change of direction.
3. Access doors or panels shall be of the same material and thickness of the duct with gaskets and sealants that are rated 815 degrees C (1500 degrees F) and shall be grease-tight.
4. Grease Duct: Double-wall factory-built grease duct, UL labeled and complying with NFPA 96 may be furnished in lieu of specified materials for kitchen and grill hood exhaust. Installation and accessories shall comply with the manufacturers catalog data. Outer jacket of exposed ductwork shall be stainless steel. Square and rectangular duct shown in the drawings will have to be converted to equivalent round size.

F. Round and Flat Oval Ducts: Furnish duct and fittings made by the same manufacturer to insure good fit of slip joints. When submitted and approved in advance, round and flat oval duct, with size converted on the basis of equal pressure drop, may be furnished in lieu of rectangular duct design shown on the drawings.

1. Elbows: Diameters 80 through 200 mm (3 through 8 inches) shall be two sections die stamped, all others shall be gored construction, maximum 18 degree angle, with all seams continuously welded or standing seam. Coat galvanized areas of fittings damaged by welding with corrosion resistant aluminum paint or galvanized repair compound.
 2. Provide bell mouth, conical tees or taps, laterals, reducers, and other low loss fittings as shown in SMACNA HVAC Duct Construction Standards.
 3. Provide flat side reinforcement of oval ducts as recommended by the manufacturer and SMACNA HVAC Duct Construction Standard S3.13. Because of high pressure loss, do not use internal tie-rod reinforcement unless approved by the Contracting Officer Technical Representative.
- G. Casings and Plenums: Construct in accordance with SMACNA HVAC Duct Construction Standards Section 6, including curbs, access doors, pipe penetrations, eliminators and drain pans. Access doors shall be hollow metal, insulated, with latches and door pulls, 500 mm (20 inches) wide by 1200 - 1350 mm (48 - 54 inches) high. Provide view port in the doors where shown. Provide drain for outside air louver plenum. Outside air plenum shall have exterior insulation. Drain piping shall be routed to the nearest floor drain.
- H. Volume Dampers: Single blade or opposed blade, multi-louver type as detailed in SMACNA Standards. Refer to SMACNA Detail Figure 2-12 for Single Blade and Figure 2.13 for Multi-blade Volume Dampers.
- I. Duct Hangers and Supports: Refer to SMACNA Standards Section IV. Avoid use of trapeze hangers for round duct.

2.3 DUCT ACCESS DOORS, PANELS AND SECTIONS

- A. Provide access doors, sized and located for maintenance work, upstream, in the following locations:
1. Each duct mounted coil and humidifier.
 2. Each fire damper (for link service), smoke damper and automatic control damper.
 3. Each duct mounted smoke detector.
 4. For cleaning operating room supply air duct and kitchen hood exhaust duct, locate access doors at 6 m (20 feet) intervals and at each change in duct direction.
- B. Openings shall be as large as feasible in small ducts, 300 mm by 300 mm (12 inch by 12 inch) minimum where possible. Access sections in insulated ducts shall be double-wall, insulated. Transparent shatterproof covers are preferred for uninsulated ducts.

1. For rectangular ducts: Refer to SMACNA HVAC Duct Construction Standards (Figure 2-12).
2. For round and flat oval duct: Refer to SMACNA HVAC duct Construction Standards (Figure 2-11).

2.4 FIRE DAMPERS

- A. Galvanized steel, interlocking blade type, UL listing and label, 1-1/2 hour rating, 70 degrees C (160 degrees F) fusible line, 100 percent free opening with no part of the blade stack or damper frame in the air stream.
- B. Fire dampers in wet air exhaust shall be of stainless steel construction, all others may be galvanized steel.
- C. Minimum requirements for fire dampers:
 1. The damper frame may be of design and length as to function as the mounting sleeve, thus eliminating the need for a separate sleeve, as allowed by UL 555. Otherwise provide sleeves and mounting angles, minimum 1.9 mm (14 gage), required to provide installation equivalent to the damper manufacturer's UL test installation.
 2. Submit manufacturer's installation instructions conforming to UL rating test.

2.5 FLEXIBLE AIR DUCT

- A. General: Factory fabricated, complying with NFPA 90A for connectors not passing through floors of buildings. Flexible ducts shall not penetrate any fire or smoke barrier which is required to have a fire resistance rating of one hour or more. Flexible duct length shall not exceed 1.5 m (5 feet). Provide insulated acoustical air duct connectors in supply air duct systems and elsewhere as shown.
- B. Flexible ducts shall be listed by Underwriters Laboratories, Inc., complying with UL 181. Ducts larger than 200 mm (8 inches) in diameter shall be Class 1. Ducts 200 mm (8 inches) in diameter and smaller may be Class 1 or Class 2.
- C. Insulated Flexible Air Duct: Factory made including mineral fiber insulation with maximum C factor of 0.25 at 24 degrees C (75 degrees F) mean temperature, encased with a low permeability moisture barrier outer jacket, having a puncture resistance of not less than 50 Beach Units. Acoustic insertion loss shall not be less than 3 dB per 300 mm (foot) of straight duct, at 500 Hz, based on 150 mm (6 inch) duct, of 750 m/min (2500 fpm).
- D. Application Criteria:
 1. Temperature range: -18 to 93 degrees C (0 to 200 degrees F) internal.
 2. Maximum working velocity: 1200 m/min (4000 feet per minute).

3. Minimum working pressure, inches of water gage: 2500 Pa (10 inches) positive, 500 Pa (2 inches) negative.

- E. Duct Clamps: 100 percent nylon strap, 80 kg (175 pounds) minimum loop tensile strength manufactured for this purpose or stainless steel strap with cadmium plated worm gear tightening device. Apply clamps with sealant and as approved for UL 181, Class 1 installation.

2.6 FLEXIBLE DUCT CONNECTIONS

Where duct connections are made to fans, air terminal units, and air handling units, install a non-combustible flexible connection of 822 g (29 ounce) neoprene coated fiberglass fabric approximately 150 mm (6 inches) wide. For connections exposed to sun and weather provide hypalon coating in lieu of neoprene. Burning characteristics shall conform to NFPA 90A. Securely fasten flexible connections to round ducts with stainless steel or zinc-coated iron draw bands with worm gear fastener. For rectangular connections, crimp fabric to sheet metal and fasten sheet metal to ducts by screws 50 mm (2 inches) on center. Fabric shall not be stressed other than by air pressure. Allow at least 25 mm (one inch) slack to insure that no vibration is transmitted.

2.7 PREFABRICATED ROOF CURBS

Galvanized steel or extruded aluminum 300 mm (12 inches) above finish roof service, continuous welded corner seams, treated wood nailer, 40 mm (1-1/2 inch) thick, 48 kg/cubic meter (3 pound/cubic feet) density rigid mineral fiberboard insulation with metal liner, built-in cant strip (except for gypsum or tectum decks). For surface insulated roof deck, provide raised cant strip (recessed mounting flange) to start at the upper surface of the insulation. Curbs shall be constructed for pitched roof or ridge mounting as required to keep top of curb level.

2.8 FIRESTOPPING MATERIAL

Refer to Section 07 84 00, FIRESTOPPING.

2.9 DUCT MOUNTED THERMOMETER (AIR)

- A. Stem Type Thermometers: ASTM E1, 7 inch scale, red appearing mercury, lens front tube, cast aluminum case with enamel finish and clear glass or polycarbonate window, brass stem, 2 percent of scale accuracy to ASTM E77 scale calibrated in degrees Fahrenheit.
- B. Thermometer Supports:
1. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.
 2. Flange: 3 inch outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.10 DUCT MOUNTED TEMPERATURE SENSOR (AIR)

Refer to Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.

2.11 INSTRUMENT TEST FITTINGS

- A. Manufactured type with a minimum 50 mm (two inch) length for insulated duct, and a minimum 25 mm (one inch) length for duct not insulated. Test hole shall have a flat gasket for rectangular ducts and a concave gasket for round ducts at the base, and a screw cap to prevent air leakage.
- B. Provide instrument test holes at each duct or casing mounted temperature sensor or transmitter, and at entering and leaving side of each heating coil, cooling coil, and heat recovery unit.

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Comply with provisions of Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION, particularly regarding coordination with other trades and work in existing buildings.
- B. Fabricate and install ductwork and accessories in accordance with referenced SMACNA Standards:
 - 1. Drawings show the general layout of ductwork and accessories but do not show all required fittings and offsets that may be necessary to connect ducts to equipment, boxes, diffusers, grilles, etc., and to coordinate with other trades. Fabricate ductwork based on field measurements. Provide all necessary fittings and offsets at no additional cost to the Government. Coordinate with other trades for space available and relative location of HVAC equipment and accessories on ceiling grid. Duct sizes on the drawings are inside dimensions which shall be altered by Contractor to other dimensions with the same air handling characteristics where necessary to avoid interferences and clearance difficulties.
 - 2. Provide duct transitions, offsets and connections to dampers, coils, and other equipment in accordance with SMACNA Standards, Section II. Provide streamliner, when an obstruction cannot be avoided and must be taken in by a duct. Repair galvanized areas with galvanizing repair compound.
 - 3. Provide bolted construction and tie-rod reinforcement in accordance with SMACNA Standards.
 - 4. Construct casings, eliminators, and pipe penetrations in accordance with SMACNA Standards, Chapter 6. Design casing access doors to swing against air pressure so that pressure helps to maintain a tight seal.

- C. Install duct hangers and supports in accordance with SMACNA Standards, Chapter 4.
- D. Install fire dampers, smoke dampers and combination fire/smoke dampers in accordance with the manufacturer's instructions to conform to the installation used for the rating test. Install fire dampers, smoke dampers and combination fire/smoke dampers at locations indicated and where ducts penetrate fire rated and/or smoke rated walls, shafts and where required by the Contracting Officer Technical Representative. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges per UL and NFPA. Demonstrate re-setting of fire dampers and operation of smoke dampers to the Contracting Officer Technical Representative.
- E. Seal openings around duct penetrations of floors and fire rated partitions with fire stop material as required by NFPA 90A.
- F. Flexible duct installation: Refer to SMACNA Standards, Chapter 3. Ducts shall be continuous, single pieces not over 1.5 m (5 feet) long (NFPA 90A), as straight and short as feasible, adequately supported. Centerline radius of bends shall be not less than two duct diameters. Make connections with clamps as recommended by SMACNA. Clamp per SMACNA with one clamp on the core duct and one on the insulation jacket. Flexible ducts shall not penetrate floors, or any chase or partition designated as a fire or smoke barrier, including corridor partitions fire rated one hour or two hour. Support ducts SMACNA Standards.
- G. Where diffusers, registers and grilles cannot be installed to avoid seeing inside the duct, paint the inside of the duct with flat black paint to reduce visibility.
- H. Control Damper Installation:
 - 1. Provide necessary blank-off plates required to install dampers that are smaller than duct size. Provide necessary transitions required to install dampers larger than duct size.
 - 2. Assemble multiple sections dampers with required interconnecting linkage and extend required number of shafts through duct for external mounting of damper motors.
 - 3. Provide necessary sheet metal baffle plates to eliminate stratification and provide air volumes specified. Locate baffles by experimentation, and affix and seal permanently in place, only after stratification problem has been eliminated.
 - 4. Install all damper control/adjustment devices on stand-offs to allow complete coverage of insulation.

- I. Air Flow Measuring Devices (AFMD): Install units with minimum straight run distances, upstream and downstream as recommended by the manufacturer.
- J. Protection and Cleaning: Adequately protect equipment and materials against physical damage. Place equipment in first class operating condition, or return to source of supply for repair or replacement, as determined by Contracting Officer Technical Representative. Protect equipment and ducts during construction against entry of foreign matter to the inside and clean both inside and outside before operation and painting. When new ducts are connected to existing ductwork, clean both new and existing ductwork by mopping and vacuum cleaning inside and outside before operation.

3.2 DUCT LEAKAGE TESTS AND REPAIR

- A. Ductwork leakage testing shall be performed by the Testing and Balancing Contractor directly contracted by the General Contractor and independent of the Sheet Metal Contractor.
- B. Ductwork leakage testing shall be performed for the entire air distribution system (including all supply, return, exhaust and relief ductwork), section by section, including fans, coils and filter sections.
- C. Test procedure, apparatus and report shall conform to SMACNA Leakage Test manual. The maximum leakage rate allowed is 4 percent of the design air flow rate.
- D. All ductwork shall be leak tested first before enclosed in a shaft or covered in other inaccessible areas.
- E. All tests shall be performed in the presence of the Contracting Officer Technical Representative and the Test and Balance agency. The Test and Balance agency shall measure and record duct leakage and report to the Contracting Officer Technical Representative and identify leakage source with excessive leakage.
- F. If any portion of the duct system tested fails to meet the permissible leakage level, the Contractor shall rectify sealing of ductwork to bring it into compliance and shall retest it until acceptable leakage is demonstrated to the Contracting Officer Technical Representative.
- G. All tests and necessary repairs shall be completed prior to insulation or concealment of ductwork.
- H. Make sure all openings used for testing flow and temperatures by TAB Contractor are sealed properly.

3.3 TESTING, ADJUSTING AND BALANCING (TAB)

Refer to Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC.

3.4 OPERATING AND PERFORMANCE TESTS

Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM
GENERATION

- - - E N D - - -

SECTION 23 34 00
HVAC FANS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Fans for heating, ventilating and air conditioning.
- B. Product Definitions: AMCA Publication 99, Standard 1-66.

1.2 RELATED WORK

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.
- D. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT.
- E. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.
- F. Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.
- G. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
- H. Section 23 73 00, INDOOR CENTRAL-STATION AIR-HANDLING UNITS.
- I. Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS.

1.3 QUALITY ASSURANCE

- A. Refer to paragraph, QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.
- B. Fans and power ventilators shall be listed in the current edition of AMCA 261, and shall bear the AMCA performance seal.
- C. Operating Limits for Centrifugal Fans: AMCA 99 (Class I, II, and III).
- D. Fans and power ventilators shall comply with the following standards:
 - 1. Testing and Rating: AMCA 210.
 - 2. Sound Rating: AMCA 300.
- E. Vibration Tolerance for Fans and Power Ventilators: Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.
- F. Performance Criteria:
 - 1. The fan schedule shall show the design air volume and static pressure. Select the fan motor HP by increasing the fan BHP by 10 percent to account for the drive losses and field conditions.
 - 2. Select the fan operating point as follows:
 - a. Forward Curve and Axial Flow Fans: Right hand side of peak pressure point
 - b. Air Foil, Backward Inclined, or Tubular: At or near the peak static efficiency

- G. Safety Criteria: Provide manufacturer's standard screen on fan inlet and discharge where exposed to operating and maintenance personnel.
- H. Corrosion Protection:
 - 1. Except for fans in fume hood exhaust service, all steel shall be mill-galvanized, or phosphatized and coated with minimum two coats, corrosion resistant enamel paint. Manufacturers paint and paint system shall meet the minimum specifications of: ASTM D1735 water fog; ASTM B117 salt spray; ASTM D3359 adhesion; and ASTM G152 and G153 for carbon arc light apparatus for exposure of non-metallic material.

1.4 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturers Literature and Data:
 - 1. Fan sections, motors and drives.
 - 2. Centrifugal fans, motors, drives, accessories and coatings.
 - a. Up-blast kitchen hood exhaust fans.
 - b. Industrial fans.
 - 3. Prefabricated roof curbs.
 - 4. Power roof and wall ventilators.
- C. Certified Sound power levels for each fan.
- D. Motor ratings types, electrical characteristics and accessories.
- E. Roof curbs.
- F. Belt guards.
- G. Maintenance and Operating manuals in accordance with Section 01 00 00, GENERAL REQUIREMENTS.
- H. Certified fan performance curves for each fan showing cubic feet per minute (CFM) versus static pressure, efficiency, and horsepower for design point of operation.

1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. Air Movement and Control Association International, Inc. (AMCA):
 - 99-86.....Standards Handbook
 - 210-06.....Laboratory Methods of Testing Fans for
Aerodynamic Performance Rating
 - 261-09.....Directory of Products Licensed to bear the AMCA
Certified Ratings Seal - Published Annually

- 300-08.....Reverberant Room Method for Sound Testing of Fans
- C. American Society for Testing and Materials (ASTM):
- B117-07a.....Standard Practice for Operating Salt Spray (Fog) Apparatus
- D1735-08.....Standard Practice for Testing Water Resistance of Coatings Using Water Fog Apparatus
- D3359-08.....Standard Test Methods for Measuring Adhesion by Tape Test
- G152-06.....Standard Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Non-Metallic Materials
- G153-04.....Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Non-Metallic Materials
- D. National Fire Protection Association (NFPA):
- NFPA 96-08.....Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations
- E. National Sanitation Foundation (NSF):
- 37-07.....Air Curtains for Entrance Ways in Food and Food Service Establishments
- F. Underwriters Laboratories, Inc. (UL):
- 181-2005.....Factory Made Air Ducts and Air Connectors

1.6 EXTRA MATERIALS

Provide one additional set of belts for all belt-driven fans.

PART 2 - PRODUCTS

2.1 FAN SECTION (CABINET FAN)

Refer to specification Section 23 73 00, INDOOR CENTRAL-STATION AIR-HANDLING UNITS.

2.2 CENTRIFUGAL FANS

- A. Standards and Performance Criteria: Refer to Paragraph, QUALITY ASSURANCE. Record factory vibration test results on the fan or furnish to the Contractor.
- B. Fan arrangement, unless noted or approved otherwise:
1. SWS1 fans: Arrangement 1, 3, 9 or 10, exhaust fans Arrangement 3 shall not be acceptable.
- C. Construction: Wheel diameters and outlet areas shall be in accordance with AMCA standards.

1. Housing: Low carbon steel, arc welded throughout, braced and supported by structural channel or angle iron to prevent vibration or pulsation, flanged outlet, inlet fully streamlined. Provide lifting clips, and casing drain. Provide manufacturer's standard access door. Provide 12.5 mm (1/2 inches) wire mesh screens for fan inlets without duct connections.
 2. Wheel: Steel plate with die formed blades welded or riveted in place, factory balanced statically and dynamically.
 3. Shaft: Designed to operate at no more than 70 percent of the first critical speed at the top of the speed range of the fans class.
 4. Bearings: Heavy duty ball or roller type sized to produce a B10 life of not less than 50,000 hours, and an average fatigue life of 200,000 hours. Extend filled lubrication tubes for interior bearings or ducted units to outside of housing.
 5. Belts: Oil resistant, non-sparking and non-static.
 6. Belt Drives: Factory installed with final alignment belt adjustment made after installation.
 7. Motors and Fan Wheel Pulleys: Adjustable pitch for use with motors through 15HP, fixed pitch for use with motors larger than 15HP. Select pulleys so that pitch adjustment is at the middle of the adjustment range at fan design conditions.
 8. Motor, adjustable motor base, drive and guard: Furnish from factory with fan. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION for specifications. Provide protective sheet metal enclosure for fans located outdoors.
- D. Utility Fans, Vent Sets and Small Capacity Fans: Class 1 design, arc welded housing, spun intake cone.
1. Applicable construction specification, paragraphs A and C, for centrifugal fans shall apply for wheel diameters 300 mm (12 inches) and larger. Requirement for AMCA seal is waived for wheel diameters less than 300 mm (12 inches) and housings may be cast iron.
 2. For kitchen hood exhaust applications, fan shall be labeled for grease removal in accordance with UL 762. Provide grease trap, weatherhood, 1-inch threaded drain connection, and bolted access door. Fan shall be arranged in upblast configuration.
- E. Prefabricated Equipment Rails: As specified in paragraph 2.4 of this section.

2.3 POWER ROOF VENTILATOR

- A. Standards and Performance Criteria: Refer to Paragraph, QUALITY ASSURANCE.

- B. Type: Centrifugal fan, backward inclined blades. Provide down-blast or up-blast type as indicated.
- C. Construction: Aluminum, completely weatherproof, for curb mounting, exhaust cowl or entire drive assembly readily removable for servicing, aluminum bird screen on discharge, UL approved safety disconnect switch, conduit for wiring, vibration isolators for wheel, motor and drive assembly.
- D. Motor and Drive: Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION. Bearings shall be pillow block ball type with a minimum L-50 life of 200,000 hours. Motor shall be located out of air stream.
- E. Prefabricated Roof Curb: As specified in paragraph 2.4 of this section.
- F. Up-blast Type: Top discharge exhauster, motor out of air stream. For kitchen hood exhaust applications, provide grease trough on base and threaded drain. The mounting height of the kitchen up-blast exhaust fan shall be in compliance with NFPA 96. Provide vented curb extension if required to maintain required clearances. Kitchen up-blast fans shall have hinged bases, with aluminum hinges. Include restraint cable. Mount fan such that access to either fan or ductwork is not blocked by the fan when the base is tilted open.

2.4 PREFABRICATED ROOF CURBS AND EQUIPMENT RAILS

- A. Galvanized steel or extruded aluminum 355 mm (14 inches) minimum above finish roof service, continuous welded corner seams, treated wood nailer, 40 mm (1-1/2 inch) thick 48 kg/cubic meter (3 pound/cubic feet) density rigid mineral fiberboard insulation with metal liner (for curbs), built-in cant strip (except for gypsum or tectum decks). For surface insulated roof deck, provide raised cant strip (recessed mounting flange) to start at the upper surface of the insulation. Curbs shall be constructed for pitched roof or ridge mounting as required to keep top of curb level.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install fan, motor and drive in accordance with manufacturer's instructions.
- B. Align fan and motor sheaves to allow belts to run true and straight.
- C. Bolt equipment to curbs with galvanized lag bolts.
- D. Install vibration control devices as shown on drawings and specified in Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.

3.2 PRE-OPERATION MAINTENANCE

- A. Lubricate bearings, pulleys, belts and other moving parts with manufacturer recommended lubricants.
- B. Rotate impeller by hand and check for shifting during shipment and check all bolts, collars, and other parts for tightness.
- C. Clean fan interiors to remove foreign material and construction dirt and dust.

3.3 START-UP AND INSTRUCTIONS

- A. Verify operation of motor, drive system and fan wheel according to the drawings and specifications.
- B. Check vibration and correct as necessary for air balance work.
- C. After air balancing is complete and permanent sheaves are in place perform necessary field mechanical balancing to meet vibration tolerance in Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.

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SECTION 23 36 00
AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 DESCRIPTION

Air terminal units, air flow control valves.

1.2 RELATED WORK

- A. Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION: General mechanical requirements and items, which are common to more than one section of Division 23.
- B. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT: Noise requirements.
- C. Section 23 31 00, HVAC DUCTS AND CASINGS: Ducts and flexible connectors.
- D. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC: Valve operators.
- E. Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC: Flow rates adjusting and balancing.

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

1.4 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data:
 - 1. Air Terminal Units: Submit test data.
- C. Operation and Maintenance Manuals: Submit in accordance with paragraph, INSTRUCTIONS, in Section 01 00 00, GENERAL REQUIREMENTS.

1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. Air Conditioning and Refrigeration Institute (AHRI)/(ARI):
 - 880-08.....Air Terminals Addendum to ARI 888-98
incorporated into standard posted 15th December
2002
- C. National Fire Protection Association (NFPA):
 - 90A-09.....Standard for the Installation of Air
Conditioning and Ventilating Systems

D. Underwriters Laboratories, Inc. (UL):

181-08.....Standard for Factory-Made Air Ducts and Air
Connectors

E. American Society for Testing and Materials (ASTM):

C 665-06.....Standard Specification for Mineral-Fiber
Blanket Thermal Insulation for Light Frame
Construction and Manufactured Housing

1.6 GUARANTY

In accordance with the GENERAL REQUIREMENTS.

PART 2 - PRODUCTS

2.1 GENERAL

A. Coils:

1. Water Heating Coils:

- a. ARI certified, continuous plate or spiral fin type, leak tested at 2070 kPa (300 PSI).
- b. Capacity: As indicated, based on scheduled entering water temperature.
- c. Headers: Copper or Brass.
- d. Fins: Aluminum, maximum 315 fins per meter (8 fins per inch).
- e. Tubes: Copper, arrange for counter-flow of heating water.
- f. Water Flow Rate: Minimum 0.032 Liters/second (0.5 GPM).
- g. Provide vent and drain connection at high and low point, respectively of each coil.
- h. Coils shall be guaranteed to drain.

B. Labeling: Control box shall be clearly marked with an identification label that lists such information as nominal CFM, maximum and minimum factory-set airflow limits, coil type and coil connection orientation, where applicable.

C. Factory calibrate air terminal units to air flow rate indicated. All settings including maximum and minimum air flow shall be field adjustable.

2.2 AIR TERMINAL UNITS (BOXES)

A. General: Factory built, pressure independent units, factory set-field adjustable air flow rate, suitable for single duct applications. Use of dual-duct air terminal units is not permitted. Clearly show on each unit the unit number and factory set air volumes corresponding to the contract drawings. Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC work assumes factory set air volumes. Coordinate flow

controller sequence and damper operation details with the drawings and Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC. All air terminal units shall be brand new products of the same manufacturer.

- B. Capacity and Performance: The Maximum Capacity of a single terminal unit shall not exceed 566 Liters/second (1,200 CFM) with the exception of operating rooms and Cystoscopy rooms, which shall be served by a single air terminal unit at a maximum of 1,250 Liters/second (3,000 CFM).

- C. Sound Power Levels:

Acoustic performance of the air terminal units shall be based on the design noise levels for the spaces stipulated in Section 23 05 41 (Noise and Vibration Control for HVAC Piping and Equipment). Equipment schedule shall show the sound power levels in all octave bands. Terminal sound attenuators shall be provided, as required, to meet the intent of the design.

- D. Casing: Unit casing shall be constructed of galvanized steel no lighter than 0.85 mm (22 Gauge). Air terminal units serving the operating rooms and Cystoscopy rooms shall be fabricated without lining. Provide hanger brackets for attachment of supports.

1. Lining material: Suitable to provide required acoustic performance, thermal insulation and prevent sweating. Meet the requirements of NFPA 90A and comply with UL 181 for erosion as well as ASTM C 665 antimicrobial requirements. Insulation shall consist of 13 mm (1/2 IN) thick non-porous foil faced rigid fiberglass insulation of 4-lb/cu.ft, secured by full length galvanized steel z-strips which enclose and seal all edges. Tape and adhesives shall not be used. Materials shall be non-friable and with surfaces, including all edges, fully encapsulated and faced with perforated metal or coated so that the air stream will not detach material. No lining material is permitted in the boxes serving operating rooms and Cystoscopy rooms.

2. Access panels (or doors): Provide panels large enough for inspection, adjustment and maintenance without disconnecting ducts, and for cleaning heating coils attached to unit, even if there are no moving parts. Panels shall be insulated to same standards as the rest of the casing and shall be secured and gasketed airtight. It shall require no tool other than a screwdriver to remove.

3. Total leakage from casing: Not to exceed 2 percent of the nominal capacity of the unit when subjected to a static pressure of 750 Pa (3 inch WG), with all outlets sealed shut and inlets fully open.
- E. Construct dampers and other internal devices of corrosion resisting materials which do not require lubrication or other periodic maintenance.
 1. Damper Leakage: Not greater than 2 percent of maximum rated capacity, when closed against inlet static pressure of 1 kPa (4 inch WG).
- F. Provide multi-point velocity pressure sensors with external pressure taps.
 1. Provide direct reading air flow rate table pasted to box.
- G. Provide static pressure tubes.
- H. Externally powered DDC variable air volume controller and damper actuator to be furnished under Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC for factory mounting on air terminal units. The DDC controller shall be electrically actuated.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Work shall be installed as shown and according to the manufacturer's diagrams and recommendations.
- B. Handle and install units in accordance with manufacturer's written instructions.
- C. Support units rigidly so they remain stationary at all times. Cross-bracing or other means of stiffening shall be provided as necessary. Method of support shall be such that distortion and malfunction of units cannot occur.
- D. Locate air terminal units to provide a straight section of inlet duct for proper functioning of volume controls. See VA Standard Detail.

3.2 OPERATIONAL TEST

Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

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SECTION 23 37 00
AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Air Outlets and Inlets: Diffusers, Registers, and Grilles.

1.2 RELATED WORK

- A. Outdoor and Exhaust Louvers: Section 08 90 00, LOUVERS AND VENTS.
- B. Kitchen Hoods: Section 23 38 13, COMMERCIAL-KITCHEN HOODS.
- C. General Mechanical Requirements: Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.
- D. Noise Level Requirements: Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.
- E. Testing and Balancing of Air Flows: Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.

1.3 QUALITY ASSURANCE

- A. Refer to article, QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.
- B. Fire Safety Code: Comply with NFPA 90A.

1.4 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data:
1. Air intake/exhaust hoods.
 2. Diffusers, registers, grilles and accessories.
- C. Coordination Drawings: Refer to article, SUBMITTALS, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. Air Diffusion Council Test Code:
1062 GRD-84.....Certification, Rating, and Test Manual 4th Edition
- C. American Society of Civil Engineers (ASCE):
ASCE7-05.....Minimum Design Loads for Buildings and Other Structures
- D.....American Society for Testing and Materials (ASTM):

- A167-99 (2004).....Standard Specification for Stainless and
Heat-Resisting Chromium-Nickel Steel Plate,
Sheet and Strip
- B209-07.....Standard Specification for Aluminum and
Aluminum-Alloy Sheet and Plate
- E. National Fire Protection Association (NFPA):
- 90A-09.....Standard for the Installation of Air
Conditioning and Ventilating Systems
- F. Underwriters Laboratories, Inc. (UL):
- 181-08.....UL Standard for Safety Factory-Made Air Ducts
and Connectors

PART 2 - PRODUCTS

2.1 EQUIPMENT SUPPORTS

Refer to Section 21 05 11, COMMON WORK RESULTS FOR FIRE SUPPRESSION,
Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING, and Section 23 05 11,
COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

2.2 AIR OUTLETS AND INLETS

A. Materials:

1. Steel or aluminum. Provide manufacturer's standard gasket.
2. Exposed Fastenings: The same material as the respective inlet or outlet. Fasteners for aluminum may be stainless steel.
3. Contractor shall review all ceiling drawings and details and provide all ceiling mounted devices with appropriate dimensions and trim for the specific locations.

B. Performance Test Data: In accordance with Air Diffusion Council Code 1062GRD. Refer to Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT for NC criteria.

C. Air Supply Outlets:

1. Ceiling Diffusers: Suitable for surface mounting, exposed T-bar or special tile ceilings, off-white finish, square or round neck connection as shown on the drawings. Provide plaster frame for units in plaster ceilings.
 - a. Louver face type: Square or rectangular, removable core for 1, 2, 3, or 4 way directional pattern. Provide equalizing or control grid and opposed blade damper.

D. Return and Exhaust Registers and Grilles: Provide opposed blade damper without removable key operator for registers.

1. Finish: Off-white baked enamel for ceiling mounted units. Wall units shall have a prime coat for field painting, or shall be extruded aluminum with manufacturer's standard aluminum finish.
2. Standard Type: Fixed horizontal face bars set at 30 to 45 degrees, approximately 30 mm (1-1/4 inch) margin.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with provisions of Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION, particularly regarding coordination with other trades and work in existing buildings.
- B. Protection and Cleaning: Protect equipment and materials against physical damage. Place equipment in first class operating condition, or return to source of supply for repair or replacement, as determined by Contracting Officer Technical Representative. Protect equipment during construction against entry of foreign matter to the inside and clean both inside and outside before operation and painting.

3.2 TESTING, ADJUSTING AND BALANCING (TAB)

Refer to Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.

3.3 OPERATING AND PERFORMANCE TESTS

Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION

- - - E N D - - -

SECTION 23 38 13
COMMERCIAL-KITCHEN HOODS

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies food service, grease-extracting, energy saving, exhaust ventilators.

1.2 DEFINITIONS

- A. Ventilator, kitchen hood, hood and canopy; for purposes of this specification section, these terms all have the same definition.
- B. UL Listed grease extractor: a slotted (not mesh) type grease extractor that has been tested and rated by Underwriters Laboratories.
- C. Eyebrow, compensating, short circuit, short cycle types are not allowed.

1.3 RELATED WORK

- A. Section 05 50 00, METAL FABRICATIONS: Supports for Ventilators.
- B. Section 11 44 00, FOOD COOKING EQUIPMENT: Cooking Equipment.
- C. Section 11 40 21, FOOD SERVICE EQUIPMENT-UTILITY DISTRIBUTION SYSTEM: Utility Distribution Systems.
- D. Section 23 34 00, HVAC FANS: Up-blast kitchen hood exhaust fans.
- E. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC: Remote monitoring of the kitchen ventilation system.
- F. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Electrical Connections.

1.4 QUALITY CONTROL

- A. Installer Qualifications: Experienced in food service equipment installation or supervised by an experienced food service equipment installer.
 - 1. Where required to complete equipment installation, electrician and plumber shall be licensed in jurisdiction where project is located.
- B. NSF Compliance: Equipment bears NSF Certification Mark or UL Classification Mark indicating compliance with applicable NSF standards, including NSF/ANSI 2, NSF 2-Supplement, and NSF/ANSI 4.
- C. UL Listing: Equipment has been evaluated according to UL 710, is listed in UL "Heating, Cooling, Ventilating and Cooking Equipment Directory," and is labeled for intended use.
- D. Fire-Protection Systems: Comply with NFPA 96 and NFPA 17A.
- E. Welding: Perform welding according to AWS D9.1M/D9.1.

- F. In-Use Service: At least one factory-authorized service agency for equipment shall be located in the geographical area of the installation and shall have the ability to provide service within 24 hours after receiving a service call.

1.5 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data:
 - 1. Include manufacturer's address and telephone number.
 - 2. Include catalog or model numbers, and illustrations and descriptions of ventilators and accessories.
- C. Installation Drawings: Show dimensions; method of assembly; and details of installation, adjoining construction, coordination with service utilities, and other work required for a complete installation.
- D. Field Test Reports: Indicate dates and times of tests and certify test results.
- E. Operating Instructions: Include operating instructions covering operation of all components and maintenance procedures covering proper cleaning and necessary lubrication or adjustments to controls.

1.6 WARRANTY

- A. Warrant food service equipment to be free from defects in materials and workmanship in accordance with requirements of "Warranty of Construction" article in FAR clause 52.246-21.

1.7 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Welding Society (AWS):
 - D9.1M/D9.1-2006.....Sheet Metal Welding Code
- C. ASTM International (ASTM):
 - A666-03.....Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
- D. National Association of Architectural Metal Manufacturers (NAAMM):
 - AMP500-06.....Metal Finishes Manual for Architectural and Metal Products, 2006

E. NFPA International (NFPA):

#96-2008.....Standard for Ventilation Control and Fire
Protection of Commercial Cooking Operations

F. NSF International/American National Standards Institute (NSF/ANSI):

Standard #2-2009.....Food Service Equipment

Standard #4-2009.....Commercial Cooking, Rethermalization, and
Powered Hot Food Holding and Transport
Equipment

G. Sheet Metal and Air Conditioning Contractors' National Association
(SMACNA):

1767-2001.....Kitchen Ventilation Systems and Food Service
Equipment Fabrication and Installation
Guidelines

H. Underwriters Laboratories Inc. (UL):

#710-06.....Exhaust Hoods for Commercial Cooking Equipment

PART 2 - PRODUCTS

2.1 EXHAUST HOODS

- A. The hood shall be constructed of a minimum of 18 gauge, (type 304) stainless steel with a #3 finish. Hood shall be constructed using the standing seam method for optimum strength. The seams on the canopy shall be welded liquidtight, and all exposed external welds shall be ground and polished to match the original finish of the metal. Lighter material gauges, alternate material types and finishes (400 series stainless steel, cold rolled steel, etc.) and non-liquidtight welding (tack weld, spot weld, etc.) is not acceptable. Construction shall include corrosion-resistant steel framing members for strength. Short circuit style hoods are not allowed.
- B. Hood shall include UL listed and NSF certified grease extractor type, high efficiency cartridge style baffle filters of adequate number and sizes to ensure optimum performance in accordance with manufacturer's published information. The filter housing shall terminate in a pitched, full length grease trough, which shall drain into a removable grease container. Hood shall be provided with one (1) filter removal tool.
- C. Vapor proof, UL Listed, Incandescent or LED light (per plan) fixtures shall be prewired to a junction box situated at the top of the hood for field connection. Wiring shall conform to the requirements of the National Electrical Code (NEC #70).

1. Maintain minimum 75 foot-candles of light at all working surfaces.
 2. 120 volt input, mounted and wired to wall switch.
 3. Replaceable LED's without fixture removal.
 4. Warm white color, 3,000-3,500 degrees, K.
- D. Demand ventilator control system shall be installed in the hood. The demand system shall sense the heat/smoke/vapor and shall vary the speed of the exhaust fan according to the need. The demand system shall utilize various types of sensors to accomplish this, such as exhaust temperature sensor, optic sensor, carbon dioxide sensor and other state of the art sensing devices. Basis of design: Melink Corp.
- E. Fire protection systems: Wet chemical with wall-mounted stainless-steel cabinet.
1. Fire-protection system to provide duct, plenum, and surface protection for ventilator and equipment located below ventilator.
 2. System interwired with shunt trip breaker and gas solenoid valve of equipment located below ventilator for power and fuel shutoff during system actuation.
- F. Options
1. Enclosure Panels: 1.3 mm (0.05 inch) thick stainless steel shall be installed; locate between ventilator top and ceiling on all exposed sides.
 2. Back shall be unfinished.(ALL EXPOSED AREAS OF HOOD TO BE FINISHED)
 3. Stainless-steel wall flashing shall be installed on wall behind and on the side(s) of ventilator from wall curb to bottom of ventilator.
 4. Remote monitoring of the demand ventilation control showing what is transpiring during the course of a day. Provide remote monitoring of the kitchen ventilation system via the DDC control system.
Coordinate interface with Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
 5. Fresh air make-up plenum incorporated into the front face of the hood or provided at ceiling line immediately in front of the hood.

2.2 UNIT SPECIFICATIONS

Item #63 Exhaust Hood, Pizza

1. Reference Drawing FSE-3, & FSE-13 Section "B"
2. Basis of Design: Captive Aire #6030-ND-2-PSP-F

Item #64 Fire Suppression System, Pizza

1. Reference Drawing FSE-3
2. Basis of Design: Ansul R-102

Item #82 Island Exhaust Hood, Main Kitchen

1. Reference Drawing FSE-3, & FSE-13 Section "D"
2. Mid Sections to be cut away for continuous capture area.
3. Basis of Design: Captive Aire #6030-ND-2-PSP-F

Item #83 Fire Suppression System, Main Kitchen

1. Reference Drawing FSE-3
2. Basis of Design: Ansul R-102

Item #90 Exhaust Hood, Fresh Choice Bistro

1. Reference Drawing FSE-2, & FSE-13 Section "F"
2. Basis of Design: Captive Aire #6030-ND-2-PSP-F

Item #91 Fire Suppression System, Fresh Choice Bistro

1. Reference Drawing FSE-2
2. Basis of Design: Ansul R-102

Item #94 Island Exhaust Hood, Sauté

1. Reference Drawing FSE-2, & FSE-13 Section "C"
2. Basis of Design: Halton #KVV w/ Capture Jet

Item #95 Fire Suppression System, Sauté

1. Reference Drawing FSE-2
2. Basis of Design: Ansul R-102

Item #104 Exhaust Hood, Temporary Kitchen

1. Reference Drawing FSE-4, & FSE-13 Section "A"
2. Basis of Design: Captive Aire #6624-ND-2

Item #105 Fire Suppression System, Temporary Kitchen

1. Reference Drawing FSE-4
2. Basis of Design: Ansul R-102

Item #114 Exhaust Hood, Rotisserie

1. Reference Drawing FSE-2, & FSE-13 Section "E"
2. Basis of Design: Captive Aire #5430-ND-2-PSP-F

Item #115 Fire Suppression System, Rotisserie

1. Reference Drawing FSE-2
2. Basis of Design: Ansul R-102

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Install ventilators level and plumb with access clearances required for operation, maintenance and cleaning and in accordance with the manufacturer's published documentation.
- B. Coordinate installation of ventilators with overhead supports; see Section 05 50 00, METAL FABRICATIONS.
- C. Interconnect ventilators to service utilities.

3.2 FIELD TESTING

- A. Field Testing, General: Following installation, test ventilators for compliance with specified requirements and those of authorities having jurisdiction. Perform testing after air-handling systems have been balanced and adjusted.
- B. Smoke Test:
 1. Test Conditions:
 - a. Perform tests with cooking equipment served by ventilator turned off.
 - b. Perform tests with supply and exhaust fans serving the food service kitchen area turned on.
 2. Test Procedure: Move a smoke bomb around the perimeter of cooking equipment at the top surface.
 3. Test-Performance Requirements: No visible smoke shall escape from the ventilator canopy into the room.
- C. Demand Ventilator Control Test:
 1. Test Conditions:
 - a. Perform tests with cooking equipment served by exhaust ventilator turned off.
 - b. Perform tests with air-handling units serving food service kitchen turned on.

2. Test Procedure: Turn on equipment and measure speed of exhaust fan(s) as equipment heats up. Move a smoke bomb around the perimeter of the cooking equipment at the top surface and continue to measure speed of exhaust fan(s).
 3. Test-Performance Requirements: Speed of fan(s) should increase/decrease with the severity of the heat or smoke.
 4. Test-Performance Requirements: No visible smoke shall escape from the ventilator canopy into the room.
- D. Wet Fire Extinguishing System: Test system to verify that equipment operation complies with NFPA 96 and NFPA 17A.

3.3 CLEAN-UP

- A. At completion of the installation, clean and adjust equipment as required to produce ready-for-use condition.
- B. Where stainless-steel surfaces are damaged during installation procedures, repair finishes to match adjoining undamaged surfaces.
- C. Sealing and trimming
 1. Completely seal any crack, crevice, or space against entrance of food particles or vermin by means of trim strips, collars, or commercial sealant, including but not limited to
 - a. Between equipment and walls, ceilings, and floors.
 - b. Between equipment and adjoining non-portable units.
 - c. Around service and utility lines.
 - d. Between service and utility lines and walls.
 - e. Under fixtures without legs, seal water tight to base, floor.
 - f. Include sealing screw slots when screws are in food contact or splash zones.
 2. Sealant, when not exposed to extreme heat, shall be
 - a. Food Grade Silicone Sealant in appropriate color.
 - b. Used to span no more than 1/4"
 - c. Finished smooth and be easily cleanable.
 3. Use sealants only in structurally sound joints and seams.
 4. Close any opening in excess of 1/4" using proper field joints or trim.
 5. Enclose ends of hollow sections with the same material as the finish of the unit.
 6. Close openings around utilities using cleanable collars, grommets, or flexible form gaskets.

7. Weld and finish trim strips to be consistent with adjacent work.
8. Sealants will not be utilized in food and splash contact surfaces to fill open spaces or voids which result from improper installation or fabrication.
9. VOC Content: Adhesives, sealants, paints and coatings used on the interior of the building shall comply with VOC limits as seen in Section 01 81 13, Sustainable Design Requirements.

3.4 INSTRUCTIONS

- A Instruct personnel and transmit operating instructions in accordance with requirements.

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SECTION 23 40 00
HVAC AIR CLEANING DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Air filters for heating, ventilating and air conditioning.
- B. Definitions: Refer to ASHRAE Standard 52.1 for definitions of face velocity, net effective filtering area, media velocity, resistance pressure drop), atmospheric dust spot efficiency and dust-holding capacity. ASHRAE Standard 52.1 measures arrestance, dust spot efficiency and dust holding capacity of filters.
- C. Refer to ASHRAE Standard 52.2 for definitions of MERV (Minimum Efficiency Reporting Value), PSE (Particle Size Efficiency) and particle size ranges for each MERV number. ASHRAE Standard 52.2 measures particle size efficiency (PSE).

1.2 RELATED WORK

- A. General mechanical requirements and items, which are common to more than one section of Division 23: Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.
- B. Filter housing and racks: Section 23 73 00, INDOOR CENTRAL-STATION AIR-HANDLING UNITS.

1.3 QUALITY ASSURANCE

- A. Air Filter Performance Report for Extended Surface Filters:
 - 1. Submit a test report for each Grade of filter being offered. The report shall not be more than three (3) years old and prepared by using test equipment, method and duct section as specified by ASHRAE Standards 52.1 and 52.2 for type filter under test and acceptable to Contracting Officer Technical Representative, indicating that filters comply with the requirements of this specification. Test for 150 m/min (500 fpm) will be accepted for lower velocity rated filters provided the test report of an independent testing laboratory complies with all the requirements of this specification.

1.4 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data:
 - 1. Holding frames. Identify locations.
 - 2. Side access housings. Identify locations, verify insulated doors.
 - 3. Magnehelic gages.

- C. Air Filter performance reports.
- D. Suppliers warranty.
- E. Field test results for HEPA filters as per paragraph 2.3.E.3.

1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by basic designation only.
- B. American Society of Heating, Refrigerating and Air-conditioning Engineers, Inc. (ASHRAE):
 - 52.1-92R.....Gravimetric and Dust-Spot procedures for Testing Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter
 - 52.2-2007.....Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
- C. American Society of Mechanical Engineers (ASME):
 - NQA-1-2008.....Quality Assurance Requirements for Nuclear Facilities Applications
- D. Underwriters Laboratories, Inc. (UL):
 - 586;Amendment 20 March 2000 High-Efficiency, Particulate, Air Filter Units
 - 900;Revision 15 July 2009 Test Performance of Air Filter Units

PART 2 - PRODUCTS

2.1 REPLACEMENT FILTER ELEMENTS TO BE FURNISHED

- A. To allow temporary use of HVAC systems for testing and in accordance with Paragraph, TEMPORARY USE OF MECHANICAL AND ELECTRICAL SYSTEMS in Section 01 00 00, GENERAL REQUIREMENTS, provide one complete set of spare filters to the Contracting Officer Technical Representative.
- B. The Contracting Officer Technical Representative will direct whether these additional filters will either be installed as replacements for dirty units or turned over to VA for future use as replacements.
- C. Filter Classification: UL approved Class 1 or Class 2 conforming to UL Standard 900.
- D. Filter Grades, Percent, Average ASHRAE Efficiency and Controlled Containment:

Table 2.2C

Filter Grades				
MERV Value ASHRAE 52.2	Application	Dust-Spot Efficiency ASHRAE 52.1	Particle Size	Thickness /Type
7	Pre-Filter	25 to 30%	3 to 10 Microns	50 mm (2-inch) Throwaway
8	Pre-Filter	30 to 35%	3 to 10 Microns	50 mm (2-inch) Throwaway
11	After-Filter	60 to 65%	1 to 3 Microns	150 mm (6-inch) Rigid Cartridge
13	After-Filter	80 to 90%	0.3 to 1 Micron	300 mm (12-inch) Rigid Cartridge
14	After-Filter	90 to 95%	0.3 to 1 Micron	300 mm (12-inch) Rigid Cartridge
17	Final-Filter	99.97%	0.3 Microns	HEPA - IEST A

E. Filter Media:

1. MERV 11, 13, and 14 Supported (Rigid Pleated) Type: Media shall be composed of high density glass fibers or other suitable fibers. Fastening methods used to maintain pleat shape, (metal backing or aluminum separators) shall be sealed in a proper enclosing frame to insure no air leakage for life of filter. Staples and stays are prohibited.
2. MERV 7 and 8 (Pleated) Type: Media shall be composed of synthetic/natural fibers. Media shall maintain uniform pleat shape and stability for proper air flow and maximum dust loading. The media frame shall be constructed of aluminized steel. Bond the pleated media pack on all four edges to insure no air leakage for the life of the filter. Staples and stays are prohibited.

F. Filter Efficiency and Arrestance: Efficiency and arrestance of filters shall be determined in accordance with ASHRAE Standard 52.1, and MERV value in accordance with ASHRAE Standard 52.2.

G. Maximum initial resistance, recommended change over pressure drop, and maximum recommended final resistance, PA (inches of water), for each filter cartridge when operated at 150 m/min (500 feet per minute) face velocity shall be as specified in Table 2.2.F:

Table 2.2.F

Filter Initial and Final Resistance			
	Initial Resistance	Maximum Recommended Change Over Pressure Drop	Maximum Final Resistance
MERV 7 (2-inch deep)	78 (0.31)	156 (0.62)	250 (1.00)
MERV 8 (2-inch deep)	95 (0.38)	190 (0.76)	250 (1.00)
MERV 11 (12-inch deep)	60 (0.24)	120 (0.48)	375 (1.50)
MERV 13 (12-inch deep)	125 (0.50)	250 (1.00)	375 (1.50)
MERV 14 (12-inch deep)	170 (0.68)	340 (1.36)	375 (1.50)

H. Equipment Identification: Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

2.2 INSTRUMENTATION

- A. Magnehelic Differential Pressure Filter Gages: Nominal 100 mm (four inch) diameter, zero to 500 Pa (zero to two inch water gage), three inch for HEPA) range. Gauges shall be flush-mounted in aluminum panel board, complete with static tips, copper or aluminum tubing, and accessory items to provide zero adjustment.
- B. DDC static (differential) air pressure measuring station. Refer to Specification Section 23 09 23 DIRECT DIGITAL CONTROL SYSTEM FOR HVAC
- C. Provide one DDC sensor across each extended surface filter. Provide Petcocks for each gauge or sensor.
- D. Provide one common filter gauge for two-stage filter banks with isolation valves to allow differential pressure measurement.

2.3 HVAC EQUIPMENT FACTORY FILTERS

- A. Manufacturer standard filters within fabricated packaged equipment should be specified with the equipment and should adhere to industry standard.
- B. Cleanable filters are not permitted.
- C. Automatic Roll Type filters are not permitted.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install supports, filters and gages in accordance with manufacturer's instructions.
- B. Label clearly with words "Contaminated Air" on exhaust ducts leading to the HEPA filter housing.

3.2 START-UP AND TEMPORARY USE

- A. Clean and vacuum air handling units and plenums prior to starting air handling systems.
- B. Install or deliver replacement filter units as directed by the Contracting Officer Technical Representative.

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SECTION 23 73 00
INDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Air handling units including integral components specified herein.
- B. Definitions: Air Handling Unit (AHU): A factory fabricated and tested assembly of modular sections consisting of single or multiple plenum fans with direct-drive and variable frequency drives, coils, filters, and other necessary equipment to perform one or more of the following functions of circulating, cleaning, heating, cooling, humidifying, dehumidifying, and mixing of air. Design capacities of units shall be as scheduled on the drawings.

1.2 RELATED WORK

- A. General mechanical requirements and items, which are common to more than one section of Division 23: Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.
- B. Sound and vibration requirements: Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.
- C. Piping and duct insulation: Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION.
- D. Piping and valves: Section 23 21 13 / 23 22 13, HYDRONIC PIPING / STEAM AND CONDENSATE HEATING PIPING.
- E. Heating and cooling coils and pressure requirements: Section 23 82 16, AIR COILS.
- F. Return and exhaust fans: Section 23 34 00, HVAC FANS.
- G. Requirements for flexible duct connectors, sound attenuators and sound absorbing duct lining, and air leakage: Section 23 31 00, HVAC DUCTS and CASINGS.
- H. Air filters and filters' efficiency: Section 23 40 00, HVAC AIR CLEANING DEVICES.
- I. HVAC controls: Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
- J. Testing, adjusting and balancing of air and water flows: Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.
- K. Types of motors: Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT.
- L. Types of motor starters: Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS.
- M. General Commissioning: Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS
- N. HVAC Commissioning: Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS

1.3 QUALITY ASSURANCE

- A. Refer to Article, Quality Assurance, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.
- B. Air Handling Units Certification
 - 1. Air Handling Units with Plenum Fans:
 - a. Air Handling Units with a single Plenum Fan shall be certified in accordance with AHRI 430 and tested/rated in accordance with AHRI 260.
 - b. Air handling Units with Multiple Fans in an Array shall be tested and rated in accordance with AHRI 430 and AHRI 260.
- C. Heating, Cooling, and Air Handling Capacity and Performance Standards: AHRI 430, AHRI 410, ASHRAE 51, and AMCA 210.
- D. Performance Criteria:
 - 1. The fan BHP shall include all system effects for all fans and v-belt drive losses for housed centrifugal fans.
 - 2. The fan motor shall be selected within the rated nameplate capacity, without relying upon NEMA Standard Service Factor.
 - 3. Select the fan operating point as follows:
 - a. Forward Curve and Axial Flow Fans: Right hand side of peak pressure point.
 - b. Air Foil, Backward Inclined, or Tubular Fans Including Plenum Fans: At or near the peak static efficiency but at an appropriate distance from the stall line.
 - 4. Operating Limits: AMCA 99 and Manufacturer's Recommendations.
- E. Units shall be factory-fabricated, assembled, and tested by a manufacturer, in business of manufacturing similar air-handling units for at least three (3) years.

1.4. SUBMITTALS:

- A. The contractor shall, in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, furnish a complete submission for all air handling units covered in the project. The submission shall include all information listed below. Partial and incomplete submissions shall be rejected without reviews.
- B. Manufacturer's Literature and Data:
 - 1. Submittals for AHUs shall include fans, drives, motors, coils, mixing box with outside/return air dampers, filter housings, and all other related accessories. The contractor shall provide custom drawings showing total air handling unit assembly including dimensions, operating weight, access sections, flexible connections, door swings,

- controls penetrations, electrical disconnect, lights, duplex receptacles, switches, wiring, utility connection points, unit support system, vibration isolators, drain pan, pressure drops through each component (filter, coil etc).
2. Submittal drawings of section or component only will not be acceptable. Contractor shall also submit performance data including performance test results, charts, curves or certified computer selection data; data sheets; fabrication and insulation details. If the unit cannot be shipped in one piece, the contractor shall indicate the number of pieces that each unit will have to be broken into to meet shipping and job site rigging requirements. This data shall be submitted in hard copies and in electronic version compatible to AutoCAD version used by the VA at the time of submission.
 3. Submit sound power levels in each octave band for the inlet and discharge of the fan and at entrance and discharge of AHUs at scheduled conditions. In absence of sound power ratings refer to Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.
 4. Provide fan curves showing Liters/Second (cubic feet per minute), static pressure, efficiency, and horsepower for design point of operation and at maximum design Liters/Second (cubic feet per minute).
 5. Submit total fan static pressure, external static pressure, for AHU including total, inlet and discharge pressures, and itemized specified internal losses and unspecified internal losses. Refer to air handling unit schedule on drawings.
 6. Submit power and wiring diagrams.
- C. Maintenance and operating manuals in accordance with Section 01 00 00, GENERAL REQUIREMENTS. Include instructions for lubrication, filter replacement, motor and drive replacement, spare part lists, and wiring diagrams.
- D. Submit written test procedures two weeks prior to factory testing. Submit written results of factory tests for approval prior to shipping.
- E. Submit shipping information that clearly indicates how the units will be shipped in compliance with the descriptions below.
1. Units shall be shipped in one (1) piece where possible and in shrink wrapping to protect the unit from dirt, moisture and/or road salt.

2. If not shipped in one (1) piece, provide manufacturer approved shipping splits where required for installation or to meet shipping and/or job site rigging requirements in modular sections. Indicate clearly that the shipping splits shown in the submittals have been verified to accommodate the construction constraints for rigging as required to complete installation and removal of any section for replacement through available access without adversely affecting other sections.
3. If shipping splits are provided, each component shall be individually shrink wrapped to protect the unit and all necessary hardware (e.g. bolts, gaskets etc.) will be included to assemble unit on site (see section 2.1.A4).
4. Lifting lugs will be provided to facilitate rigging on shipping splits and joining of segments. If the unit cannot be shipped in one piece, the contractor shall indicate the number of pieces that each unit will have to be broken into to meet shipping and job site rigging requirements.

1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. Air-Conditioning, Heating, and Refrigeration Institute (AHRI)/(ARI):
 - 410-01.....Standard for Forced-Circulation Air-Heating and Air-Cooling Coils
 - 430-09.....Central Station Air Handling Units
- C. Air Movement and Control Association International, Inc. (AMCA):
 - 210-07.....Laboratory Methods of Testing Fans for Rating
- D. American Society of Heating, Refrigerating and Air-conditioning Engineers, Inc. (ASHRAE):
 - 170-2008.....Ventilation of Health Care Facilities
- E. American Society for Testing and Materials (ASTM):
 - ASTM B117-07a.....Standard Practice for Operating Salt Spray (Fog) Apparatus
 - ASTM D1654-08.....Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
 - ASTM D1735-08.....Standard Practice for Testing Water Resistance of Coatings Using Water Fog Apparatus
 - ASTM D3359-08.....Standard Test Methods for Measuring Adhesion by Tape Test

F. Military Specifications (Mil. Spec.):

MIL-P-21035B-2003.....Paint, High Zinc Dust Content, Galvanizing
Repair (Metric)

G. National Fire Protection Association (NFPA):

NFPA 90A.....Standard for Installation of Air Conditioning
and Ventilating Systems, 2009

H. Energy Policy Act of 2005 (P.L.109-58)

PART 2 - PRODUCTS

2.1 AIR HANDLING UNITS

A. General:

1. AHUs shall be fabricated from insulated, solid double-wall galvanized steel without any perforations in draw-through configuration. Casing shall be fabricated as specified in section 2.1.C.2. Galvanizing shall be hot dipped conforming to ASTM A525 and shall provide a minimum of 0.275 kg of zinc per square meter (0.90 oz. of zinc per square foot) (G90). Aluminum constructed units, subject to VA approval, may be used in place of galvanized steel. The unit manufacturer shall provide published documentation confirming that the structural rigidity of aluminum air-handling units is equal or greater than the specified galvanized steel.
2. The contractor and the AHU manufacturer shall be responsible for ensuring that the unit will not exceed the allocated space shown on the drawings, including required clearances for service and future overhaul or removal of unit components. All structural, piping, wiring, and ductwork alterations of units, which are dimensionally different than those specified, shall be the responsibility of the contractor at no additional cost to the government.
3. AHUs shall be fully assembled by the manufacturer in the factory in accordance with the arrangement shown on the drawings. The unit shall be assembled into the largest sections possible subject to shipping and rigging restrictions. The correct fit of all components and casing sections shall be verified in the factory for all units prior to shipment. All units shall be fully assembled, tested, and then split to accommodate shipment and job site rigging. On units not shipped fully assembled, the manufacturer shall tag each section and include air flow direction to facilitate assembly at the job site. Lifting lugs or shipping skids shall be provided for each section to allow for field rigging and final placement of unit.

4. The AHU manufacturer shall provide the necessary gasketing, caulking, and all screws, nuts, and bolts required for assembly. The manufacturer shall provide a factory-trained and qualified local representative at the job site to supervise the assembly and to assure that the units are assembled to meet manufacturer's recommendations and requirements noted on the drawings. Provide documentation to the Contracting Officer that the local representative has provided services of similar magnitude and complexity on jobs of comparable size. If a local representative cannot be provided, the manufacturer shall provide a factory representative.
5. Gaskets: All door and casing and panel gaskets and gaskets between air handling unit components, if joined in the field, shall be high quality which seal air tight and retain their structural integrity and sealing capability after repeated assembly and disassembly of bolted panels and opening and closing of hinged components. Bolted sections may use a more permanent gasketing method provided they are not disassembled.
6. Structural Rigidity: Provide structural reinforcement when required by span or loading so that the deflection of the assembled structure shall not exceed 1/200 of the span based on a differential static pressure of 1991 PA (8 inch WG) or higher.

B. Base:

1. Provide a heavy duty steel base for supporting all major AHU components. Bases shall be constructed of wide-flange steel I-beams, channels, or minimum 125 mm (5 inch) high 3.5 mm (10 Gauge) steel base rails. Welded or bolted cross members shall be provided as required for lateral stability. Contractor shall provide supplemental steel supports as required to obtain proper operation heights for cooling coil condensate drain trap and steam coil condensate return trap as shown on drawings.
2. AHUs shall be completely self supporting for installation on concrete housekeeping pad, steel support pedestals, or suspended as shown on drawings.
3. The AHU bases not constructed of galvanized steel shall be cleaned, primed with a rust inhibiting primer, and finished with rust inhibiting exterior enamel.

C. Casing (including wall, floor and roof):

1. General: AHU casing shall be constructed as solid double wall, galvanized steel insulated panels without any perforations, integral

of or attached to a structural frame. The thickness of insulation, mode of application and thermal breaks shall be such that there is no visible condensation on the exterior panels of the AHU located in the non-conditioned spaces.

2. Casing Construction:

Table 2.1.C.2

Outer Panel	0.8 mm (22 Gage) Minimum
Inner Panel	0.8 mm (22 Gage) Minimum
Insulation	Foam
Thickness	50 mm (2 inch) Minimum
Density	48 kg/m ³ (3.0 lb/ft ³) Minimum
Total R Value	2.3 m ² .K/W (13.0 ft ² .°F.hr/Btu) Minimum

3. Casing Construction (Contractor's Option):

Table 2.1.C.3

Outer Panel	1.3 mm (18 Gage) Minimum
Inner Panel	1.0 mm (20 Gage) Minimum
Insulation	Fiberglass
Thickness	50 mm (2 inch) Minimum
Density	24 kg/m ³ (1.5 lb/ft ³) Minimum
Total R Value	1.4 m ² .K/W (8.0 ft ² .°F.hr/Btu) Minimum

4. Blank-Off: Provide blank-offs as required to prevent air bypass between the AHU sections, around coils, and filters.
5. Casing panels shall be secured to the support structure with stainless steel or zinc-chromate plated screws and gaskets installed around the panel perimeter. Panels shall be completely removable to allow removal of fan, coils, and other internal components for future maintenance, repair, or modifications. Welded exterior panels are not acceptable.
6. Access Doors: Provide in each access section and where shown on drawings. Show single-sided and double-sided access doors with door swings on the floor plans. Doors shall be a minimum of 50 mm (2 inch) thick with same double wall construction as the unit casing. Doors shall be a minimum of 600 mm (24 inches) wide, unless shown of different size on drawings, and shall be the full casing height up to a maximum of 1850 mm (6 feet). Doors shall be gasketed, hinged, and

latched to provide an airtight seal. The access doors for fan section, mixing box, and coil section shall include a minimum 150 mm x 150 mm (6 inch x 6 inch) double thickness, with air space between the glass panes tightly sealed, reinforced glass or Plexiglas window in a gasketed frame.

- a. Hinges: Manufacturers standard, designed for door size, weight and pressure classifications. Hinges shall hold door completely rigid with minimum 45 kg (100 lb) weight hung on latch side of door.
 - b. Latches: Non-corrosive alloy construction, with operating levers for positive cam action, operable from either inside or outside. Doors that do not open against unit operating pressure shall allow the door to ajar and then require approximately 0.785 radian (45 degrees) further movement of the handle for complete opening. Latch shall be capable of restraining explosive opening of door with a force not less than 1991 Pa (8 inch WG).
 - c. Gaskets: Neoprene, continuous around door, positioned for direct compression with no sliding action between the door and gasket. Secure with high quality mastic to eliminate possibility of gasket slipping or coming loose.
7. Provide sealed sleeves, metal or plastic escutcheons or grommets for penetrations through casing for power and temperature control wiring and pneumatic tubing. Coordinate with electrical and temperature control subcontractors for number and location of penetrations. Coordinate lights, switches, and duplex receptacles and disconnect switch location and mounting. All penetrations and equipment mounting may be provided in the factory or in the field. All field penetrations shall be performed neatly by drilling or saw cutting. No cutting by torches will be allowed. Neatly seal all openings airtight.

D. Floor:

1. Unit floor shall be level without offset space or gap and designed to support a minimum of 488 kg/square meter (100 lbs per square foot) distributed load without permanent deformation or crushing of internal insulation. Provide adequate structural base members beneath floor in service access sections to support typical service foot traffic and to prevent damage to unit floor or internal insulation. Unit floors in casing sections, which may contain water or condensate, shall be watertight with drain pan.

2. Where indicated, furnish and install floor drains, flush with the floor, with nonferrous grate cover and stub through floor for external connection.
- E. Condensate Drain Pan: Drain pan shall be designed to extend entire length of cooling coils including headers and return bends. Depth of drain pan shall be at least 43 mm (1.7 inches) and shall handle all condensate without overflowing. Drain pan shall be double-wall, double sloping type, and fabricated from stainless (304) with at least 50 mm (2 inch) thick insulation sandwiched between the inner and outer surfaces. Drain pan shall be continuous metal or welded watertight. No mastic sealing of joints exposed to water will be permitted. Drain pan shall be placed on top of casing floor or integrated into casing floor assembly. Drain pan shall be pitched in all directions to drain line.
1. An intermediate, stainless-steel (304) condensate drip pan with copper downspouts shall be provided on stacked cooling coils. Use of intermediate condensate drain channel on upper casing of lower coil is permissible provided it is readily cleanable. Design of intermediate condensate drain shall prevent upper coil condensate from flowing across face of lower coil.
 2. Drain pan shall be piped to the exterior of the unit. Drain pan shall be readily cleanable.
 3. Installation, including frame, shall be designed and sealed to prevent blow-by.
- F. Plenum Fans - Single and/or Multiple Fans in an Array:
1. General: Fans shall be Class II (minimum) construction with single inlet, aluminum wheel and stamped air-foil aluminum bladed. The fan wheel shall be mounted on the directly-driven motor shaft in AMCA Arrangement 4. Fans shall be dynamically balanced and internally isolated to minimize the vibrations. Provide a steel inlet cone for each wheel to match with the fan inlet. Locate fan in the air stream to assure proper flow. The fan performance shall be rated in accordance with AMCA 210 or ASHRAE 51.
 2. Allowable vibration tolerances for fan shall not exceed a self-excited vibration maximum velocity of 0.005 m/s (0.20 inch per second) RMS, filter in, when measured with a vibration meter on bearing caps of machine in vertical, horizontal and axial directions or measured at equipment mounting feet if bearings are concealed. After field installation, compliance to this requirement shall be demonstrated with field test in accordance with Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT and Section

23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC. Following fan assembly, the complete fan assembly balance shall be tested using an electronic balance analyzer with a tunable filter and stroboscope. Vibration measurements shall be taken on each motor bearing housing in the vertical, horizontal, and axial planes (5 total measurements, 2 each motor bearing and 1 axial).

3. The plenum fans shall be driven by variable speed drives with at least one back-up drive as shown in the design documents. Use of a drive with bypass is not permitted.
4. Multiple fans shall be installed in a pre-engineered structural frame to facilitate fan stacking. Redundancy requirement shall be met by all operating fans in an array and without the provision of an idle standby fan.

5. Fan Accessories

- a. Fan Isolation: Provide an automatic back draft damper to isolate the fan not in operation due to failure.
- b. Fan Airflow Measurement: Provide an airflow measuring device integral to the fan to measure air volume within +/- 5 percent accuracy. The probing device shall not be placed in the airflow path to stay clear of turbulence and avoid loss of performance.

G. Fan Motor, Drive, and Mounting Assembly (Plenum Fans):

Fan Motor and Drive: Motors shall be premium energy efficient type, as mandated by the Energy Policy Act of 2005, with efficiencies as shown in the Specifications Section 23 05 12 (General Motor Requirements For HVAC and Steam Equipment), on drawings and suitable for use in variable frequency drive applications. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION, for additional motor and drive specifications. Refer to Specification Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS

- H. Multi-zone damper blades shall be galvanized steel or aluminum type. Dampers shall have metal compressible jamb seals and extruded vinyl or metal blade edge seals. Dampers shall rotate on stainless steel bearings or bronze bushings. Leakage rate shall not exceed 1.25 cubic meters/minute/square meter (4 CFM per sq. foot) at 250 Pa (1 inch WG). Dampers and operators shall be furnished and factory installed by AHU manufacturer. Damper operators shall be of the same manufacturer as controls furnished under Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.

- I. Mixing Boxes: Mixing box shall consist of casing and outdoor air and return air dampers in opposed blade arrangement with damper linkage for automatic operation. Coordinate damper operator with Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC. Dampers shall be of ultra-low leak design with metal compressible bronze jamb seals and extruded vinyl edge seals on all blades. Blades shall rotate on stainless steel sleeve bearings or bronze bushings. Leakage rate shall not exceed 1.6 cubic meters/min/square meter (5 CFM per square foot) at 250 Pa (1 inch WG) and 2.8 cubic meters/min/square meter (9 CFM per square foot) at 995 Pa (4 inch WG) Electronic operators shall be furnished and mounted in an accessible and easily serviceable location by the air handling unit manufacturer at the factory. Damper operators shall be of same manufacturer as controls furnished under Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
- J. Filter Section: Refer to Section 23 40 00, HVAC AIR CLEANING DEVICES, for filter requirements.
1. Filters including one complete set for temporary use at site shall be provided independent of the AHU. The AHU manufacturer shall install filter housings and racks in filter section compatible with filters furnished. The AHU manufacturer shall be responsible for furnishing temporary filters (pre-filters and after-filters, as shown on drawings) required for AHU testing.
 2. Factory-fabricated filter section shall be of the same construction and finish as the AHU casing including filter racks and hinged double wall access doors. Filter housings shall be constructed in accordance with side service or holding frame housing requirements in Section 23 40 00, HVAC AIR CLEANING DEVICES.
- K. Coils: Coils shall be mounted on hot dipped galvanized steel supports to assure proper anchoring of coil and future maintenance. Coils shall be face or side removable for future replacement thru the access doors or removable panels. Each coil shall be removable without disturbing adjacent coil. Cooling coils shall be designed and installed to insure no condensate carry over. Provide factory installed extended supply, return, drain, and vent piping connections. Refer to Drawings and Section 23 82 16, AIR COILS for additional coil requirements.
1. Water Coils.

2. Integral Face and Bypass Steam Coils: Provide integral vertical face and bypass dampers. Electric damper operators shall be furnished and mounted by the AHU manufacturer at the factory. Damper operators shall be of same manufacturer as controls furnished under Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
 3. Steam Distributing Tube Coils.
- L. Discharge Section:
- Provide aerodynamically designed framed discharge openings or spun bellmouth fittings to minimize pressure loss.
- M. Electrical and Lighting: Wiring and equipment specifications shall conform to Division 26, ELECTRICAL.
1. Vapor-proof lights using cast aluminum base style with glass globe and cast aluminum guard shall be installed in access sections for fan, mixing box, and any section over 300 mm (12 inch) wide. A switch shall control the lights in each compartment with pilot light mounted outside the respective compartment accessdoor. Wiring between switches and lights shall be factory installed. All wiring shall run in neatly installed electrical conduits and terminate in a junction box for field connection to the building system. Provide single point 115 volt - one phase connection at junction box.
 2. Install compatible 100 watt bulb in each light fixture.
 3. Provide a convenience duplex receptacle next to the light switch.
 4. Disconnect switch and power wiring: Provide factory or field mounted non-fused disconnect switch. Coordinate with Division 26, ELECTRICAL.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install air handling unit in conformance with ARI 435.
- B. Assemble air handling unit components following manufacturer's instructions for handling, testing and operation. Repair damaged galvanized areas with paint in accordance with Military Spec. DOD-P-21035. Repair painted units by touch up of all scratches with finish paint material. Vacuum the interior of air handling units clean prior to operation.
- C. Leakage and test requirements for air handling units shall be the same as specified for ductwork in Specification Section 23 31 00, HVAC DUCTS AND CASINGS except leakage shall not exceed Leakage Class (C_L) 12 listed in SMACNA HVAC Air Duct Leakage Test Manual when tested at 1.5 times the design static pressure. Repair casing air leaks that can be heard or felt during normal operation and to meet test requirements.

- D. Perform field mechanical (vibration) balancing in accordance with Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.
- E. Seal and/or fill all openings between the casing and AHU components and utility connections to prevent air leakage or bypass.

3.2 STARTUP SERVICES

- A. The air handling unit shall not be operated for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings are lubricated and fan has been test run under observation.
- B. After the air handling unit is installed and tested, provide startup and operating instructions to VA personnel.
- C. An authorized factory representative should start up, test and certify the final installation and application specific calibration of control components. Items to be verified include fan performance over entire operating range, noise and vibration testing, verification of proper alignment, overall inspection of the installation, Owner/Operator training, etc.

3.3 COMMISSIONING

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

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SECTION 23 74 13
PACKAGED, OUTDOOR, CUSTOM AIR-HANDLING AND PENTHOUSE UNITS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Roof top air handling units including integral components specified herein.
- B. Definitions: Roof Top Air Handling Unit and Roof Top Custom Penthouse(Roof Top Units, RTU): A factory fabricated assembly consisting of fan, coils, filters, and other necessary equipment to perform one or more of the following functions of circulating, cleaning, heating, cooling, humidifying, dehumidifying, and mixing of air. Design capacities of units shall be as scheduled on the drawings.

1.2 RELATED WORK

- A. Section 23 05 11, COMMON WORK RESULTS FOR HVAC: General mechanical requirements and items, which are common to more than one section of Division 23.
- B. Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT: Sound and vibration requirements.
- C. Section 23 07 11, HVAC and BOILER PLANT INSULATION: Piping and duct insulation.
- D. Section 23 21 13, HYDRONIC PIPING and Section 23 22 13, STEAM and CONDENSATE HEATING PIPING: Piping and valves.
- E. Section 23 82 16, AIR COILS: Heating and cooling coils and pressure requirements.
- F. Section 23 34 00, HVAC FANS: Return and exhaust fans.
- G. Section 23 31 00, HVAC DUCTS and CASINGS: Requirements for flexible duct connectors, sound attenuators and sound absorbing duct lining.
- H. Section 23 40 00, HVAC AIR CLEANING DEVICES: Air filters and filters' efficiency.
- I. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC: HVAC controls.
- J. Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC: Testing, adjusting and balancing of air and water flows.
- K. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION EQUIPMENT: Types of motors.
- L. Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS: Types of motor starters.
- M. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS:
- N. Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS: Requirements for commissioning, systems readiness checklists, and training.

1.3 QUALITY ASSURANCE

- A. Refer to Article, Quality Assurance, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Air Handling Units Certification
 - 1. Air Handling Units with Plenum Fans:
 - a. Air Handling Units with a single Plenum Fan shall be certified in accordance with AHRI 430 and tested/rated in accordance with AHRI 260.
 - b. Air handling Units with Multiple Fans in an Array shall be tested and rated in accordance with AHRI 430 and AHRI 260.
- C. Heating, Cooling, and Air Handling Capacity and Performance Standards: AHRI 430, AHRI 410, ASHRAE 51, and AMCA 210.
- D. Performance Criteria:
 - 1. The fan BHP shall include all system effects for all fans and v-belt drive losses for housed centrifugal fans.
 - 2. The fan motor shall be selected within the rated nameplate capacity, without relying upon NEMA Standard Service Factor.
 - 3. Select the fan operating point as follows:
 - a. Forward Curve and Axial Flow Fans: Right hand side of peak pressure point.
 - b. Air Foil, Backward Inclined, or Tubular Fans Including Plenum Fans: At or near the peak static efficiency but at an appropriate distance from the stall line.
 - 4. Operating Limits: AMCA 99 and Manufacturer's Recommendations.
- E. Units shall be factory-fabricated, assembled, and tested by a manufacturer, in business of manufacturing similar air-handling units for at least three (3) years.

1.4 SUBMITTALS:

- A. The contractor shall, in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES, furnish a complete submission for all roof top units covered in the project. The submission shall include all information listed below. Partial and incomplete submissions shall be rejected without reviews.
- B. Manufacturer's Literature and Data:
 - 1. Submittals for RTUs shall include fans, drives, motors, coils, mixing box with outside/return air dampers, filter housings, and all other related accessories. The contractor shall provide custom drawings showing total air handling unit assembly including dimensions, operating weight, access sections, flexible connections, door swings, controls penetrations, electrical disconnect, lights, duplex

- receptacles, switches, wiring, utility connection points, unit support system, vibration isolators, drain pan, pressure drops through each component (filter, coil etc) and rigging points.
2. Submittal drawings of section or component only, will not be acceptable. Contractor shall also submit performance data including performance test results, charts, curves or certified computer selection data; data sheets; fabrication and insulation details; if the unit cannot be shipped in one piece, the contractor shall indicate the number of pieces that each unit will have to be broken into to meet shipping and job site rigging requirements. This data shall be submitted in hard copies and in electronic version compatible to AutoCAD version used by the VAMC at the time of submission.
 3. Submit sound power levels in each octave band for fan and at entrance and discharge of RTUs at scheduled conditions. Include sound attenuator capacities and itemized internal component attenuation. Internal lining of supply air ductwork with sound absorbing material is not permitted. In absence of sound power ratings refer to Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.
 4. Provide fan curves showing Liters/Second (cubic feet per minute), static pressure, efficiency, and horsepower for design point of operation and at maximum design Liters/Second (cubic feet per minute) and 110 percent of design static pressure.
 5. Submit total fan static pressure, external static pressure, for RTU including total, inlet and discharge pressures, and itemized specified internal losses and unspecified internal losses. Refer to air handling unit schedule on drawings.
- C. Maintenance and operating manuals in accordance with Section 01 00 00, GENERAL REQUIREMENTS. Include instructions for lubrication, filter replacement, motor and drive replacement, spare part lists, and wiring diagrams.
- D. Submit written test procedures two weeks prior to factory testing. Submit written results of factory tests for approval prior to shipping.
- E. Completed System Readiness Checklists provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 23 08 00 COMMISSIONING OF HVAC SYSTEMS.

F. Submit shipping information that clearly indicates how the units will be shipped in compliance with the descriptions below.

1. Units shall be shipped in one (1) piece where possible and in shrink wrapping to protect the unit from dirt, moisture and/or road salt.
2. If not shipped in one (1) piece, provide manufacturer approved shipping splits where required for installation or to meet shipping and/or job site rigging requirements in modular sections. Indicate clearly that the shipping splits shown in the submittals have been verified to accommodate the construction constraints for rigging as required to complete installation and removal of any section for replacement through available access without adversely affecting other sections.
3. If shipping splits are provided, each component shall be individually shrink wrapped to protect the unit and all necessary hardware (e.g. bolts, gaskets etc.) will be included to assemble unit on site (see section 2.1.A4).
4. Lifting lugs will be provided to facilitate rigging on shipping splits and joining of segments. If the unit cannot be shipped in one piece, the contractor shall indicate the number of pieces that each unit will have to be broken into to meet shipping and job site rigging requirements.

1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. Air-Conditioning, Heating, and Refrigeration Institute (AHRI):
 - 260-01.....Sound Rating of Ducted Air Moving and
Conditioning Equipment
 - 410-01.....Standard for Forced-Circulation Air-Heating and
Air-Cooling Coils
 - 430-09.....Standard for Central Station Air Handling Units
 - AHRI-DCAACP.....Directory of Certified Applied Air Conditioning
Products
- C. Air Moving and Conditioning Association (AMCA):
 - 210-07.....Laboratory Methods of Testing Fans for Rating
- D. Anti-Friction Bearing Manufacturer's Association, Inc. (AFBMA):
 - 9-90 (R2008).....Load Ratings and Fatigue life for Ball Bearings

- E. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):
 - 51-2007.....Laboratory Methods of Testing Fans for Rating
- F. American Society for Testing and Materials (ASTM):
 - A653/653M-02.....Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
 - B117-07a.....Salt Spray (Fog) Testing
 - C1071-05e1.....Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)
 - D1654-08.....Standard Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
 - D1735-08.....Water Resistance of Coatings Using Water Fog Apparatus
 - D3359-08.....Standard Test Methods for Measuring Adhesion by Tape Test
 - E84-10.....Standard Test Method for Surface Burning Characteristics of Building Materials
- G. Anti-Friction Bearing Manufacturer's Association, Inc. (AFBMA):
 - 9-90.....Load Ratings and Fatigue life for Ball Bearings
- H. Military Specifications (Mil. Spec.):
 - DOD-P-21035A-2003.....Paint, High Zinc Dust Content, Galvanizing Repair
- I. National Fire Protection Association (NFPA):
 - NFPA 90A.....Standard for Installation of Air Conditioning and Ventilating Systems, 2009
- J. Energy Policy Act of 2005 (P.L.109-58)

PART 2 - PRODUCTS

2.1 ROOF TOP AIR HANDLING UNITS

A. General:

1. Roof top units (RTU) shall be fabricated from insulated, solid double-wall galvanized steel without any perforations in draw-through configuration. Casing is specified in paragraph 2.1.C. Galvanizing shall be hot dipped conforming to ASTM A525 and shall provide a minimum of 0.275 kg of zinc per square meter (0.90 oz. of zinc per square foot) (G90). Aluminum constructed units may be provided subject to VAMC approval and documentation that structural rigidity is equal or greater than the galvanized steel specified.

2. The contractor and the RTU manufacturer shall be responsible for insuring that the unit will not exceed the allocated space shown on the drawings, including required clearances for service and future overhaul or removal of unit components. All structural, piping, wiring, and ductwork alterations of units, which are dimensionally different than those specified, shall be the responsibility of the contractor at no additional cost to the government.
3. RTUs shall be fully assembled by the manufacturer in the factory in accordance with the arrangement shown on the drawings. The unit shall be assembled into the largest sections possible subject to shipping and rigging restrictions. The correct fit of all components and casing sections shall be verified in the factory for all units prior to shipment. All units shall be fully assembled, tested and then split to accommodate shipment and job site rigging. On units not shipped fully assembled, the manufacturer shall tag each section and include air flow direction to facilitate assembly at the job site. Lifting lugs or shipping skids shall be provided for each section to allow for field rigging and final placement of unit.
4. The RTU manufacturer shall provide the necessary gasketing, caulking, and all screws, nuts, and bolts required for assembly. The manufacturer shall provide a local representative at the job site to supervise the assembly and to assure the units are assembled to meet manufacturer's recommendations and requirements noted on the drawings. Provide documentation that this representative has provided this service on similar jobs to the Contracting Officer. If a local representative cannot be provided, the manufacturer shall provide a factory representative.
5. Gaskets: All door and casing and panel gaskets and gaskets between air handling unit components, if joined in the field, shall be high quality which seal air tight and retain their structural integrity and sealing capability after repeated assembly and disassembly of bolted panels and opening and closing of hinged components. Bolted sections may use a more permanent gasketing method provided they are not disassembled.
6. Structural Rigidity: Provide structural reinforcement when required by span or loading so that the deflection of the assembled structure shall not exceed 1/200 of the span based on a differential static pressure of 1991 Pa (8 inches water gage) or higher.

B. Base:

1. Provide a heavy-duty steel base for supporting all major RTU components. Bases shall be constructed of wide-flange steel I-beams, channels, or minimum 125 mm (5 inch) high 3.5 mm (10 Gauge) steel base rails. Welded or bolted cross members shall be provided as required for lateral stability. Contractor shall provide supplemental steel supports as required to obtain proper operation heights for cooling coil condensate drain trap and steam coil condensate return trap as shown on drawings.
2. RTUs shall be completely self supporting for installation on roof curb. Curb to be provided by the manufacturer, and shall meet requirements of curbs specified in Specification Section 23 34 00.
3. The RTU bases not constructed of galvanized material shall be cleaned, primed with a rust inhibiting primer, and finished with rust inhibiting exterior enamel.

C. Casing (including wall, floor and roof):

1. General: RTU casing shall be entirely double wall insulated panels, integral of or attached to a structural frame. Construction shall be such that removal of any panel shall not affect the structural integrity of the unit. Casing finished shall meet salt-spray test as specified in paragraph 2.1.C.10. All casing and panel sections shall be tightly butted and gasketed. No gaps of double wall construction will be allowed where panels bolt to air handling unit structural member. Structural members, not covered by the double wall panels, shall have equivalent insulated double wall construction.
2. Exterior finish shall be an exterior metal panel system in accordance with architectural specifications, provided by the unit manufacturer.
3. Double wall galvanized steel panels, minimum 51 mm (2 inches) thick, constructed of minimum 1.5 mm (16 gauge) outer skin and 1.0 mm (20 gauge) solid or perforated inner skin to limit wall, roof and floor deflection to not exceed an $L/240$ ratio when the unit casing is pressurized to $(\pm 1245 \text{ Pa } (\pm 5 \text{ in. w.g.}))$. Deflection shall be measured at the midpoint of the panel height. Total housing leakage shall not exceed 1% of rated cfm when the unit casing is pressurized to $\pm 5 \text{ in. w.g. } (\pm 1245 \text{ Pa})$. The outer (skin) and inner panels shall be solid.
4. Blank-Off: Provide blank-offs as required to prevent air bypass between the AHU sections, around coils, and filters.

5. Insulation: Insulation shall be injected CFC free foam encased in double-wall casing between exterior and interior panels such that no insulation can erode to the air stream. Insulation shall be 50 mm (2 inch) thick, and 48 kg/m³ (3.0 lb/ft³) density with a total thermal resistance (R-value) of approximately 2.3 m.K/W (13.0 hr-ft² °F/BTU). Units with less than 50 mm (2 inch) of insulation in any part of the walls, floor, roof or drain pan shall not be acceptable. The insulation shall comply with NFPA 90-A for the flame and smoke generation requirements. Also, refer to specification Section 23 07 11, HVAC and BOILER PLANT INSULATION.

Table 2.1.C.4

Insulation	Foam
Thickness	50 mm (2 inch) Minimum
Density	48 kg/m ³ (3.0 lb/ft ³) Minimum
Total R Value	2.3 m ² .K/W (13.0 ft ² .°F.hr/Btu) Minimum

6. The thickness of insulation, mode of application, and thermal breaks shall be such that there is no visible condensation on the exterior panels of the AHU.
7. Casing panels shall be secured to the support structure with stainless steel or zinc-chromate plated screws and gaskets installed around the panel perimeter. Panels shall be completely removable to allow removal of fan, coils, and other internal components for future maintenance, repair, or modifications. Welded exterior panels are not acceptable.
8. Access Doors: Provide in each access section and where shown on drawings. Show single-sided and double-sided access doors with door swings on the floor plans. Doors shall be a minimum of 50 mm (2 inches) thick with same double wall construction as the unit casing. Doors shall be a minimum of 600 mm (24 inches) wide, unless shown of different size on drawings, and shall be the full casing height up to a maximum of 1850 mm (6 feet). Doors shall be gasketed, hinged, and latched to provide an airtight seal. The access doors for fan section, mixing box, coil section shall include a minimum 150 mm x 150 mm (6 inch x 6 inch) double thickness, with air space between glass panes tightly sealed, reinforced glass or Plexiglas window in a gasketed frame.

- a. Hinges: Manufacturers standard, designed for door size, weight and pressure classifications. Hinges shall hold door completely rigid with minimum 45 kg (100 pound) weight hung on latch side of door.
 - b. Latches: Non-corrosive alloy construction, with operating levers for positive cam action, operable from either inside or outside. Doors that do not open against unit operating pressure shall allow the door to ajar and then require approximately 0.785 radian (45 degrees) further movement of the handle for complete opening. Latch shall be capable of restraining explosive opening of door with a force not less than 1991 Pa (8 inches water gage).
 - c. Gaskets: Neoprene, continuous around door, positioned for direct compression with no sliding action between the door and gasket. Secure with high quality mastic to eliminate possibility of gasket slipping or coming loose.
9. Provide sealed sleeves, metal or plastic escutcheons or grommets for penetrations through casing for power and temperature control wiring and pneumatic tubing. Coordinate with electrical and temperature control subcontractors for number and location of penetrations. Coordinate lights, switches, and duplex receptacles and disconnect switch location and mounting. All penetrations and equipment mounting may be provided in the factory or in the field. All field penetrations shall be performed neatly by drilling or saw cutting. No cutting by torches will be allowed. Neatly seal all openings airtight.
 10. Roof of the unit shall be sloped to have a minimum pitch of 1/4 inch per foot. The roof shall overhang the side panels by a minimum of three inches to prevent precipitation drainage from streaming down the unit side panels. Panels shall be standing seam, minimum 16 gauge steel.
 11. Service vestibule shall be separated from airflow equipment by double wall insulated panels matching exterior construction. The flooring of the service vestibule shall be 12 gauge tread plate.
 12. Outside air intake plenum shall be separated from remainder of unit by double wall insulated panels matching exterior construction.
 13. Casing finished shall meet ASTM B117, 500-hour salt spray test, using 20 percent sodium chloride solution. Immediately after completion of the test, the coating shall show no sign of blistering, wrinkling, or cracking, no loss of adhesion, and the specimen shall show no sign of rust creepage beyond 1/8-inch on either side of scratch mark.

- D. Unit floor shall be level without offset space or gap and designed to support a minimum of 488 kg/square meter (100 pounds per square foot) distributed load without permanent deformation or crushing of internal insulation. Provide adequate structural base members beneath floor in service access sections to support typical service foot traffic and to prevent damage to unit floor or internal insulation. Unit floors in casing sections, which may contain water or condensate, shall be watertight with drain pan.
- E. Condensate Drain Pan: Drain pan shall be designed to extend entire length of cooling coils including headers and return bends. Depth of drain pan shall be at least 43 mm (1.7 inches) and shall handle all condensate without overflowing. Drain pan shall be double wall construction, Type 304 stainless steel and have a minimum of 50 mm (2 inch) insulation, and shall be sloped to drain. Drain pan shall be continuous metal or welded watertight. No mastic sealing of joints exposed to water will be permitted. Drain pan shall be placed on top of casing floor or integrated into casing floor assembly. Drain pan shall be pitched in all directions to drain line.
1. An intermediate condensate drip pan shall be provided on stacked cooling coils and shall be constructed of type 304 stainless steel with copper downspouts factory piped to main condensate pan. Use of intermediate condensate drain channel on upper casing of lower coil is permissible provided it is readily cleanable. Design of intermediate condensate drain shall prevent upper coil condensate from flowing across face of lower coil.
 2. Drain pan shall be piped to the exterior of the unit. Drain pan shall be readily cleanable.
 3. Installation, including frame, shall be designed and sealed to prevent blow-by.
- F. Plenum Fans - Single and/or Multiple Fans in an Array
1. General: Fans shall be Class II (minimum) construction with single inlet, aluminum wheel and stamped air-foil aluminum bladed. The fan wheel shall be mounted on the directly-driven motor shaft in AMCA Arrangement 4. Fans shall be dynamically balanced and internally isolated to minimize the vibrations. Provide a steel inlet cone for each wheel to match with the fan inlet. Locate fan in the air stream to assure proper flow. The fan performance shall be rated in accordance with AMCA 210 or ASHRAE 51.

2. Allowable vibration tolerances for fan shall not exceed a self-excited vibration maximum velocity of 0.005 m/s (0.20 inch per second) RMS, filter in, when measured with a vibration meter on bearing caps of machine in vertical, horizontal and axial directions. After field installation, compliance to this requirement shall be demonstrated with field test in accordance with Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT and Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC. The fan wheel shall meet or exceed guidelines in AMCA 801-92 for dynamic balancing requirements. The complete fan assembly balance shall be tested using an electronic balance analyzer with a tunable filter and stroboscope. Vibration measurements shall be taken on each motor bearing housing in the vertical, horizontal, and axial planes (5 total measurements, 2 each motor bearing and 1 axial).
3. The plenum fans shall be driven by variable speed drives with at least one back-up drive as shown in the design documents. Use of a drive with bypass is not permitted.
4. Multiple fans shall be installed in a pre-engineered structural frame to facilitate fan stacking. All fans shall modulate in unison, above or below the synchronous speed within the limits specified by the manufacturer, by a common control sequence. Staging of the fans is not permitted. Redundancy requirement shall be met by all operating fans in an array and without the provision of an idle standby fan.
5. Fan Accessories
 - a. Fan Isolation: Provide an automatic back draft damper to isolate the fan not in operation due to failure.
 - b. Fan Airflow Measurement: Provide an airflow measuring device integral to the fan to measure air volume within +/- 5 percent accuracy. The probing device shall not be placed in the airflow path to stay clear of turbulence and avoid loss of performance.
6. Fan Motor, Drive and Mounting Assembly: Fan Motors shall be premium energy efficient type, as mandated by the Energy Policy Act of 2005, with efficiencies as shown in the Specifications Section 23 05 12 (General Motor Requirements For HVAC and Steam Equipment), on drawings and suitable for use in variable frequency drive applications. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION, for additional motor and drive specifications. Refer to Specification Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS

- G. Multi-zone damper blades shall be galvanized steel or aluminum type. Dampers shall have metal compressible jamb seals and extruded vinyl or metal blade edge seals. Dampers shall rotate on stainless steel bearings or bronze bushings. Leakage rate shall not exceed 2.5 cubic meters/minute/square meter (8 cfm per sq. foot) at 250 Pa (1 inch water). Dampers and operators shall be furnished and factory installed by RTU manufacturer. Damper operators shall be of the same manufacturer as controls furnished under Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
- H. Mixing Boxes: Mixing box shall consist of casing and outdoor air and return air dampers in opposed blade arrangement with damper linkage for automatic operation. Coordinate damper operator with Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC. Dampers shall be of ultra-low leak design with metal compressible bronze jamb seals and extruded vinyl edge seals on all blades. Blades shall rotate on stainless steel sleeve bearings or bronze bushings. Leakage rate shall not exceed 1.6 cubic meters/min/square meter (5 cfm per square foot) at 250 Pa (1 inch water gage) and 2.8 cubic meters/min/square meter (9 cfm per square foot) at 995 Pa (4 inches water gage) Electronic damper operators shall be furnished and mounted in an accessible and easily serviceable location by the air handling unit manufacturer at the factory. Damper operators shall be of same manufacturer as controls furnished under Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
- I. Filter Section: Refer to Section 23 40 00, HVAC AIR CLEANING DEVICES, for filter requirements.
1. Filters including one complete set for temporary use at site shall be provided independent of the RTU. The RTU manufacturer shall install filter housings and racks in filter section compatible with filters furnished. The RTU manufacturer shall be responsible for furnishing temporary filters (pre-filters and after-filters, as shown on drawings) required for RTU testing.
 2. Factory-fabricated filter section shall be of the same construction and finish as the RTU casing including filter racks and hinged double wall access doors. Filter housings shall be constructed in accordance with side service or holding frame housing requirements in Section 23 40 00, HVAC AIR CLEANING DEVICES.
- J. Coils: Coils shall be mounted on hot dipped galvanized steel supports to assure proper anchoring of coil and future maintenance. Coils shall be face or side removable for future replacement thru the access doors or removable panels. Each coil shall be removable without disturbing

adjacent coil. Cooling coils shall be designed and installed to insure no condensate carry over. Provide factory installed extended supply, return, drain, and vent piping connections. Refer to Drawings and Section 23 82 16, AIR COILS, for additional coil requirements.

1. Water Coils.
 2. Integral Face and Bypass Steam Coils: Provide integral vertical face and bypass dampers. Electric damper operators shall be furnished and mounted by the RTU manufacturer at the factory. Damper operators shall be of same manufacturer as controls furnished under Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
 3. Steam Distributing Tube Coils.
- K. Discharge Section: Provide aerodynamically designed framed discharge openings or spun bellmouth fittings to minimize pressure loss.
- L. Electrical and Lighting: Wiring and equipment specifications shall conform to Division 26, ELECTRICAL.
1. Vapor-proof lights using cast aluminum base style with glass globe and cast aluminum guard shall be installed in access sections for fan, mixing box, and any section over 300mm (12 inch) wide. A switch shall control the lights in each compartment with pilot light mounted outside the respective compartment access door. Wiring between switches and lights shall be factory installed. All wiring shall run in neatly installed electrical conduits and terminate in a junction box for field connection to the building system. Provide single point 115 volt - one phase connection at junction box.
 2. Install compatible 100 watt bulb in each light fixture.
 3. Provide a convenience duplex weatherproof receptacle next to the light switch.
 4. Disconnect switch and power wiring: Provide factory or field mounted disconnect switch. Coordinate with Division 26, ELECTRICAL.
- M. An electric horizontal discharge unit heater shall be located in the service vestibule.
- N. Units shall include stair sets at exterior doors to roof. Each stair step and landing shall be constructed of 1¼ x 3/16 bar grate. Stair steps shall have a nominal vertical spacing of 8 inches. The stair set shall be covered with rust inhibiting coating and a final coat of paint prior to shipment. Field measurement of the stair depth is required. The stair set shall ship loose for field installation by others.

- O. Relief louvers shall have stationary blades with extruded vinyl seals and automatic backdraft blades shall be entirely contained within a 4" frame. Louver components (heads, jambs, sills, blades & mullions) shall be factory assembled by the louver manufacturer. Louver sizes too large for shipping shall be built up by the contractor from factory assembled louver sections to provide overall sizes required. Louver design shall limit single section blade span to 48" and shall incorporate such other structural supports required to withstand a wind load of 20 lbs. per sq. ft.
- P. Supply and return openings at the floor shall be framed in on all four sides with 8-inch structural channel and shall be flush with the top of the roof curb. Removable, walk-on grating with an approximate free area of 78% shall cover the supply air and return air openings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install roof top unit in conformance with ARI 435.
- B. Assemble roof top unit components following manufacturer's instructions for handling, testing and operation. Repair damaged galvanized areas with paint in accordance with Military Spec. DOD-P-21035A. Repair painted units by touch up of all scratches with finish paint material. Vacuum the interior of air-handling units clean prior to operation.
- C. Leakage and test requirements for roof top units shall be the same as specified for ductwork in Specification Section 23 31 00, HVAC DUCTS AND CASINGS except leakage shall not exceed Leakage Class (C_L) 12 listed in SMACNA HVAC Air Duct Leakage Test Manual when tested at 1.5 times the design static pressure. Repair casing air leaks that can be heard or felt during normal operation and to meet test requirements.
- D. Perform field mechanical (vibration) balancing in accordance with Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.
- E. Seal and/or fill all openings between the casing and RTU components and utility connections to prevent air leakage or bypass.

3.2 STARTUP SERVICES

- A. The air handling unit shall not be operated for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings are lubricated and fan has been test run under observation.
- B. After the air handling unit is installed and tested, provide startup and operating instructions to VAMC personnel.

- C. An authorized factory representative should start up, test and certify the final installation and application specific calibration of control components. Items to be verified include fan performance over entire operating range, noise and vibration testing, verification of proper alignment, overall inspection of the installation, Owner/Operator training, etc.

3.3 COMMISSIONING

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

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SECTION 23 82 16
AIR COILS

PART 1 - GENERAL

1.1 DESCRIPTION

Heating and cooling coils for air handling unit and duct applications

1.2 RELATED WORK

- A. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Section 23 31 00, HVAC DUCTS AND CASINGS
- C. Section 23 36 00, AIR TERMINAL UNITS: Reheat coils for VAV/CV terminals.
- D. Section 23 73 00, INDOOR CENTRAL-STATION AIR-HANDLING UNITS.
- E. Section 23 74 13, PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS
- F. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS: Requirements for commissioning, systems readiness checklists, and training.
- G. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS

1.3 QUALITY ASSURANCE

- A. Refer to paragraph, QUALITY ASSURANCE, Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Unless specifically exempted by these specifications, heating and cooling coils shall be tested, rated, and certified in accordance with AHRI Standard 410 and shall bear the AHRI certification label.

1.4 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data for Heating and Cooling Coils: Submit type, size, arrangements and performance details. Present application ratings in the form of tables, charts or curves.
- C. Provide installation, operating and maintenance instructions.
- D. Certification Compliance: Evidence of listing in current ARI Directory of Certified Applied Air Conditioning Products.
- E. Coils may be submitted with Section 23 73 00, INDOOR CENTRAL-STATION AIR-HANDLING UNITS, Section 23 74 13, PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS, or Section 23 36 00, AIR TERMINAL UNITS.
- F. Completed System Readiness Checklists provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 23 08 00 COMMISSIONING OF HVAC SYSTEMS.

1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. Air Conditioning and Refrigeration Institute (AHRI):
Directory of Certified Applied Air Conditioning Products
AHRI 410-01.....Forced-Circulation Air-Cooling and Air-Heating Coils
- C. American Society for Testing and Materials (ASTM):
B75/75M-02.....Standard Specifications for Seamless Copper Tube
- D. National Fire Protection Association (NFPA):
70-11.....National Electric Code
- E. National Electric Manufacturers Association (NEMA):
250-11.....Enclosures for Electrical Equipment (1,000 Volts Maximum)
- F. Underwriters Laboratories, Inc. (UL):
1996-09.....Electric Duct Heaters

PART 2 - PRODUCTS

2.1 HEATING AND COOLING COILS

- A. Conform to ASTM B75 and AHRI 410.
- B. Tubes: Minimum 16 mm (0.625 inch) tube diameter; Seamless copper tubing.
- C. Fins: 0.1397 mm (0.0055 inch) aluminum or 0.1143 mm (0.0045 inch) copper mechanically bonded or soldered or helically wound around tubing.
- D. Headers: Copper, welded steel or cast iron. Provide seamless copper tubing or resistance welded steel tube for volatile refrigerant coils.
- E. "U" Bends, Where Used: Machine die-formed, silver brazed to tube ends.
- F. Coil Casing: 1.6 mm (16 gage) galvanized steel with tube supports at 1200 mm (48 inch) maximum spacing. Construct casing to eliminate air bypass and moisture carry-over. Provide duct connection flanges.
- G. Pressures kPa (PSIG):

Pressure	Water Coil	Steam Coil	Refrigerant Coil
Test	2070 (300)	1725 (250)	2070 (300)
Working	1380 (200)	520 (75)	1725 (250)

- H. Protection: Unless protected by the coil casing, provide cardboard, plywood, or plastic material at the factory to protect tube and finned surfaces during shipping and construction activities.

- I. Vents and Drain: Coils that are not vented or drainable by the piping system shall have capped vent/drain connections extended through coil casing.
- J. Cooling Coil Condensate Drain Pan: Section 23 73 00, INDOOR CENTRAL-STATION AIR-HANDLING UNITS or Section 23 74 13, PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS.
- K. Steam Distributing Coils: Conform to ASTM B75 and ARI 410. Minimum 9.5 mm (3/8-inch) steam distributing tubing installed concentrically in 25 mm (one-inch) OD condensing coil tubes.
- L. Integral Face and Bypass Type Steam Coil:
 - 1. Exempt from ARI Test and Certification.
 - 2. Conform to ASTM B75 and ARI 410.
 - 3. Minimum 16 mm (5/8-inch) steam tube installed in concentrically 25 mm (one-inch) OD diameter tube.
 - 4. Casing: 1.9 mm (14 gage) galvanized steel with corrosion resistant paint.
 - 5. Tubes and Bypasses: Vertical or horizontal.
- M. Dampers: Interlocking opposed blades to completely isolate coil from air flow when unit is in bypass position; 1.6 mm (16 gage) steel, coated with factory applied corrosion resistant baked enamel finish. Provide damper linkage and electric operators. Damper operators shall be of same manufacturer as controls furnished under Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.

2.2 WATER COILS, INCLUDING GLYCOL-WATER

- A. Use the same coil material as listed in Paragraphs 2.1.
- B. Drainable Type (Self Draining, Self Venting); Manufacturer standard:
 - 1. Cooling, all types.
 - 2. Heating or preheat.
 - 3. Runaround energy recovery. ARI certification of capacity adjustment is waived. See Section 23 72 00, AIR-TO-AIR ENERGY RECOVERY EQUIPMENT.
- C. Cleanable Tube Type; manufacturer standard:
 - 1. Well water applications.
 - 2. Waste water applications.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Follow coil manufacturer's instructions for handling, cleaning, installation and piping connections.
- B. Comb fins, if damaged. Eliminate air bypass or leakage at coil sections.

3.2 STARTUP AND TESTING

The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the Contracting Officer Technical Representative and Commissioning Agent. Provide a minimum of 7 days prior notice.

3.3 COMMISSIONING

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

3.4 DEMONSTRATION AND TRAINING

- A. Provide services of manufacturer's technical representative for four hours to instruct VAMC personnel in operation and maintenance of units.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS.

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SECTION 26 05 11
REQUIREMENTS FOR ELECTRICAL INSTALLATIONS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section applies to all sections of Division 26.
- B. Furnish and install electrical wiring, systems, equipment and accessories in accordance with the specifications and drawings. Capacities and ratings of motors, transformers, cable, switchboards, switchgear, panelboards, motor control centers, generators, automatic transfer switches, and other items and arrangements for the specified items are shown on drawings.
- C. Wiring ampacities specified or shown on the drawings are based on copper conductors, with the conduit and raceways accordingly sized. Aluminum conductors are prohibited.

1.2 MINIMUM REQUIREMENTS

- A. References to the International Building Code (IBC), National Electrical Code (NEC), Underwriters Laboratories, Inc. (UL) and National Fire Protection Association (NFPA) are minimum installation requirement standards.
- B. Drawings and other specification sections shall govern in those instances where requirements are greater than those specified in the above standards.

1.3 TEST STANDARDS

- A. All materials and equipment shall be listed, labeled or certified by a nationally recognized testing laboratory to meet Underwriters Laboratories, Inc., standards where test standards have been established. Equipment and materials which are not covered by UL Standards will be accepted provided equipment and material is listed, labeled, certified or otherwise determined to meet safety requirements of a nationally recognized testing laboratory. Equipment of a class which no nationally recognized testing laboratory accepts, certifies, lists, labels, or determines to be safe, will be considered if inspected or tested in accordance with national industrial standards, such as NEMA, or ANSI. Evidence of compliance shall include certified test reports and definitive shop drawings.
- B. Definitions:
 - 1. Listed; Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or

services, that maintains periodic inspection of production or listed equipment or materials or periodic evaluation of services, and whose listing states that the equipment, material, or services either meets appropriate designated standards or has been tested and found suitable for a specified purpose.

2. Labeled; Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.
3. Certified; equipment or product which:
 - a. Has been tested and found by a nationally recognized testing laboratory to meet nationally recognized standards or to be safe for use in a specified manner.
 - b. Production of equipment or product is periodically inspected by a nationally recognized testing laboratory.
 - c. Bears a label, tag, or other record of certification.
4. Nationally recognized testing laboratory; laboratory which is approved, in accordance with OSHA regulations, by the Secretary of Labor.

1.4 QUALIFICATIONS (PRODUCTS AND SERVICES)

- A. Manufacturers Qualifications: The manufacturer shall regularly and presently produce, as one of the manufacturer's principal products, the equipment and material specified for this project, and shall have manufactured the item for at least three years.
- B. Product Qualification:
 1. Manufacturer's product shall have been in satisfactory operation, on three installations of similar size and type as this project, for approximately three years.
 2. The Government reserves the right to require the Contractor to submit a list of installations where the products have been in operation before approval.
- C. Service Qualifications: There shall be a permanent service organization maintained or trained by the manufacturer which will render satisfactory service to this installation within (24) hours of receipt of notification that service is needed. Submit name and address of service organizations.

1.5 APPLICABLE PUBLICATIONS

Applicable publications listed in all Sections of Division are the latest issue, unless otherwise noted.

1.6 MANUFACTURED PRODUCTS

- A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts shall be available.
- B. When more than one unit of the same class or type of equipment is required, such units shall be the product of a single manufacturer.
- C. Equipment Assemblies and Components:
 - 1. Components of an assembled unit need not be products of the same manufacturer.
 - 2. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.
 - 3. Components shall be compatible with each other and with the total assembly for the intended service.
 - 4. Constituent parts which are similar shall be the product of a single manufacturer.
- D. Factory wiring shall be identified on the equipment being furnished and on all wiring diagrams.
- E. When Factory Testing Is Specified:
 - 1. The Government shall have the option of witnessing factory tests. The contractor shall notify the VAMC through the Contracting Officer Technical Representative (COR) a minimum of 15 working days prior to the manufacturers making the factory tests.
 - 2. Four copies of certified test reports containing all test data shall be furnished to the COR prior to final inspection and not more than 90 days after completion of the tests.
 - 3. When equipment fails to meet factory test and re-inspection is required, the contractor shall be liable for all additional expenses, including expenses of the Government.

1.7 EQUIPMENT REQUIREMENTS

Where variations from the contract requirements are requested in accordance with Section 10 00 00, GENERAL REQUIREMENTS and Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, the connecting work and related components shall include, but not be limited to additions or changes to branch circuits, circuit protective devices, conduits, wire, feeders, controls, panels and installation methods.

1.8 EQUIPMENT PROTECTION

- A. Equipment and materials shall be protected during shipment and storage against physical damage, vermin, dirt, corrosive substances, fumes, moisture, cold and rain.
 - 1. Store equipment indoors in clean dry space with uniform temperature to prevent condensation. Equipment shall include but not be limited to switchgear, switchboards, panelboards, transformers, motor control centers, motor controllers, uninterruptible power systems, enclosures, controllers, circuit protective devices, cables, wire, light fixtures, electronic equipment, and accessories.
 - 2. During installation, equipment shall be protected against entry of foreign matter; and be vacuum-cleaned both inside and outside before testing and operating. Compressed air shall not be used to clean equipment. Remove loose packing and flammable materials from inside equipment.
 - 3. Damaged equipment shall be, as determined by the COR, placed in first class operating condition or be returned to the source of supply for repair or replacement.
 - 4. Painted surfaces shall be protected with factory installed removable heavy kraft paper, sheet vinyl or equal.
 - 5. Damaged paint on equipment and materials shall be refinished with the same quality of paint and workmanship as used by the manufacturer so repaired areas are not obvious.

1.9 WORK PERFORMANCE

- A. All electrical work must comply with the requirements of NFPA 70 (NEC), NFPA 70B, NFPA 70E, OSHA Part 1910 subpart J, OSHA Part 1910 subpart S and OSHA Part 1910 subpart K in addition to other references required by contract.
- B. Job site safety and worker safety is the responsibility of the contractor.
- C. Electrical work shall be accomplished with all affected circuits or equipment de-energized. When an electrical outage cannot be accomplished in this manner for the required work, the following requirements are mandatory:
 - 1. Electricians must use full protective equipment (i.e., certified and tested insulating material to cover exposed energized electrical components, certified and tested insulated tools, etc.) while working on energized systems in accordance with NFPA 70E.

2. Electricians must wear personal protective equipment while working on energized systems in accordance with NFPA 70E.
3. Before initiating any work, a job specific work plan must be developed by the contractor with a peer review conducted and documented by the COR and VAMC staff. The work plan must include procedures to be used on and near the live electrical equipment, barriers to be installed, safety equipment to be used and exit pathways.
4. Work on energized circuits or equipment cannot begin until prior written approval is obtained from the COR.
- D. For work on existing stations, arrange, phase and perform work to assure electrical service for other buildings at all times. Refer to Article OPERATIONS AND STORAGE AREAS under Section 01 00 00, GENERAL REQUIREMENTS.
- E. New work shall be installed and connected to existing work neatly, safely and professionally. Disturbed or damaged work shall be replaced or repaired to its prior conditions, as required by Section 01 00 00, GENERAL REQUIREMENTS.
- F. Coordinate location of equipment and conduit with other trades to minimize interferences.

1.10 EQUIPMENT INSTALLATION AND REQUIREMENTS

- A. Equipment location shall be as close as practical to locations shown on the drawings.
- B. Working spaces shall not be less than specified in the NEC for all voltages specified.
- C. Inaccessible Equipment:
 1. Where the Government determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, the equipment shall be removed and reinstalled as directed at no additional cost to the Government.
 2. "Conveniently accessible" is defined as being capable of being reached quickly for operation, maintenance, or inspections without the use of ladders, or without climbing or crawling under or over obstacles such as, but not limited to, motors, pumps, belt guards, transformers, piping, ductwork, conduit and raceways.

1.11 EQUIPMENT IDENTIFICATION

- A. In addition to the requirements of the NEC, install an identification sign which clearly indicates information required for use and maintenance of items such as switchboards and switchgear, panelboards, cabinets, motor controllers (starters), fused and unfused safety

switches, automatic transfer switches, separately enclosed circuit breakers, individual breakers and controllers in switchboards, switchgear and motor control assemblies, control devices and other significant equipment.

- B. Nameplates for Normal Power System equipment shall be laminated black phenolic resin with a white core with engraved lettering. Nameplates for Essential Electrical System (EES) equipment, as defined in the NEC, shall be laminated red phenolic resin with a white core with engraved lettering. Lettering shall be a minimum of 1/2 inch [12mm] high. Nameplates shall indicate equipment designation, rated bus amperage, voltage, number of phases, number of wires, and type of EES power branch as applicable. Secure nameplates with screws.
- C. Install adhesive arc flash warning labels on all equipment as required by NFPA 70E. Label shall indicate the arc hazard boundary (inches), working distance (inches), arc flash incident energy at the working distance (calories/cm²), required PPE category and description including the glove rating, voltage rating of the equipment, limited approach distance (inches), restricted approach distance (inches), prohibited approach distance (inches), equipment/bus name, date prepared, and manufacturer name and address.

1.12 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. The Government's approval shall be obtained for all equipment and material before delivery to the job site. Delivery, storage or installation of equipment or material which has not had prior approval will not be permitted at the job site.
- C. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings and other data necessary for the Government to ascertain that the proposed equipment and materials comply with specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify equipment being submitted.
- D. Submittals for individual systems and equipment assemblies which consist of more than one item or component shall be made for the system or assembly as a whole. Partial submittals will not be considered for approval.
 - 1. Mark the submittals, "SUBMITTED UNDER SECTION_____".
 - 2. Submittals shall be marked to show specification reference including the section and paragraph numbers.
 - 3. Submit each section separately.

E. The submittals shall include the following:

1. Information that confirms compliance with contract requirements.
Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, pictures, nameplate data and test reports as required.
2. Elementary and interconnection wiring diagrams for communication and signal systems, control systems and equipment assemblies. All terminal points and wiring shall be identified on wiring diagrams.
3. Parts list which shall include those replacement parts recommended by the equipment manufacturer.

F. Manuals: Submit in accordance with Section 01 00 00, GENERAL REQUIREMENTS.

1. Maintenance and Operation Manuals: Submit as required for systems and equipment specified in the technical sections. Furnish four copies, bound in hardback binders, (manufacturer's standard binders) or an approved equivalent. Furnish one complete manual as specified in the technical section but in no case later than prior to performance of systems or equipment test, and furnish the remaining manuals prior to contract completion.
2. Inscribe the following identification on the cover: the words "MAINTENANCE AND OPERATION MANUAL," the name and location of the system, equipment, building, name of Contractor, and contract number. Include in the manual the names, addresses, and telephone numbers of each subcontractor installing the system or equipment and the local representatives for the system or equipment.
3. Provide a "Table of Contents" and assemble the manual to conform to the table of contents, with tab sheets placed before instructions covering the subject. The instructions shall be legible and easily read, with large sheets of drawings folded in.
4. The manuals shall include:
 - a. Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of the equipment.
 - b. A control sequence describing start-up, operation, and shutdown.
 - c. Description of the function of each principal item of equipment.
 - d. Installation instructions.
 - e. Safety precautions for operation and maintenance.
 - f. Diagrams and illustrations.
 - g. Periodic maintenance and testing procedures and frequencies, including replacement parts numbers and replacement frequencies.

- h. Performance data.
 - i. Pictorial "exploded" parts list with part numbers. Emphasis shall be placed on the use of special tools and instruments. The list shall indicate sources of supply, recommended spare parts, and name of servicing organization.
 - j. List of factory approved or qualified permanent servicing organizations for equipment repair and periodic testing and maintenance, including addresses and factory certification qualifications.
- G. Approvals will be based on complete submission of manuals together with shop drawings.
- H. After approval and prior to installation, furnish the COR with one sample of each of the following:
- 1. A 300 mm (12 inch) length of each type and size of wire and cable along with the tag from the coils of reels from which the samples were taken.
 - 2. Each type of conduit coupling, bushing and termination fitting.
 - 3. Conduit hangers, clamps and supports.
 - 4. Duct sealing compound.
 - 5. Each type of receptacle, toggle switch, occupancy sensor, outlet box, manual motor starter, device wall plate, engraved nameplate, wire and cable splicing and terminating material, and branch circuit single pole molded case circuit breaker.

1.13 SINGULAR NUMBER

Where any device or part of equipment is referred to in these specifications in the singular number (e.g., "the switch"), this reference shall be deemed to apply to as many such devices as are required to complete the installation as shown on the drawings.

1.14 PCB EQUIPMENT

- A. This project requires the removal, transport and disposal of electrical equipment containing Polychlorinated Biphenyl (PCB) in accordance with the Federal Toxic Substances Control Act (TSCA).
- B. The equipment for removal is shown on the drawings.
- C. The selective demolition shall be in accordance with Section 01 00 00, GENERAL REQUIREMENTS.

1.15 ACCEPTANCE CHECKS AND TESTS

The contractor shall furnish the instruments, materials and labor for field tests.

1.16 TRAINING

- A. Training shall be provided in accordance with Article 1.25, INSTRUCTIONS, of Section 01 00 00, GENERAL REQUIREMENTS.
- B. Training shall be provided for the particular equipment or system as required in each associated specification.
- C. A training schedule shall be developed and submitted by the contractor and approved by the COR at least 30 days prior to the planned training.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

- - - E N D - - -

SECTION 26 05 21
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW)

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies the furnishing, installation, and connection of the low voltage power and lighting wiring.

1.2 RELATED WORK

- A. Section 07 84 00, FIRESTOPPING: Sealing around penetrations to maintain the integrity of fire-rated construction.
- B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements that are common to more than one section.
- C. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits for cables and wiring.

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 FACTORY TESTS

Low voltage cables shall be thoroughly tested at the factory per NEMA WC-70 to ensure that there are no electrical defects. Factory tests shall be certified.

1.5 SUBMITTALS

In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:

- 1. Manufacturer's Literature and Data: Showing each cable type and rating.
- 2. Certifications: Two weeks prior to the final inspection, submit four copies of the following certifications to the COR:
 - a. Certification by the manufacturer that the materials conform to the requirements of the drawings and specifications.
 - b. Certification by the contractor that the materials have been properly installed, connected, and tested.

1.6 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are reference in the text by designation only.

- B. American Society of Testing Material (ASTM):
 - D2301-04.....Standard Specification for Vinyl Chloride
Plastic Pressure-Sensitive Electrical Insulating
Tape
- C. National Fire Protection Association (NFPA):
 - 70-11.....National Electrical Code (NEC)
- D. National Electrical Manufacturers Association (NEMA):
 - WC 70-09.....Power Cables Rated 2000 Volts or Less for the
Distribution of Electrical Energy
- E. Underwriters Laboratories, Inc. (UL):
 - 44-05.....Thermoset-Insulated Wires and Cables
 - 83-08.....Thermoplastic-Insulated Wires and Cables
 - 467-071.....Electrical Grounding and Bonding Equipment
 - 486A-486B-03.....Wire Connectors
 - 486C-04.....Splicing Wire Connectors
 - 486D-05.....Sealed Wire Connector Systems
 - 486E-94.....Equipment Wiring Terminals for Use with Aluminum
and/or Copper Conductors
 - 493-07.....Thermoplastic-Insulated Underground Feeder and
Branch Circuit Cable
 - 514B-04.....Conduit, Tubing, and Cable Fittings
 - 1479-03.....Fire Tests of Through-Penetration Fire Stops

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Conductors and cables shall be in accordance with NEMA WC-70 and as specified herein.
- B. Single Conductor:
 - 1. Shall be annealed copper.
 - 2. Shall be stranded for sizes No. 8 AWG and larger, solid for sizes No. 10 AWG and smaller.
 - 3. Shall be minimum size No. 12 AWG, except where smaller sizes are allowed herein.
- C. Insulation:
 - 1. XHHW-2 or THHN-THWN shall be in accordance with NEMA WC-70, UL 44, and UL 83.
- D. Color Code:
 - 1. Secondary service feeder and branch circuit conductors shall be color-coded as follows:

208/120 volt	Phase	480/277 volt
Black	A	Brown
Red	B	Orange
Blue	C	Yellow
White	Neutral	Gray *
* or white with colored (other than green) tracer.		

- a. Lighting circuit "switch legs" and 3-way switch "traveling wires" shall have color coding that is unique and distinct (e.g., pink and purple) from the color coding indicated above. The unique color codes shall be solid and in accordance with the NEC.
Coordinate color coding in the field with the COR.
2. Use solid color insulation or solid color coating for No. 12 AWG and No. 10 AWG branch circuit phase, neutral, and ground conductors.
3. Conductors No. 8 AWG and larger shall be color-coded using one of the following methods:
 - a. Solid color insulation or solid color coating.
 - b. Stripes, bands, or hash marks of color specified above.
 - c. Color as specified using 0.75 in [19 mm] wide tape. Apply tape in half-overlapping turns for a minimum of 3 in [75 mm] for terminal points, and in junction boxes, pull-boxes, troughs, and manholes. Apply the last two laps of tape with no tension to prevent possible unwinding. Where cable markings are covered by tape, apply tags to cable, stating size and insulation type.
4. For modifications and additions to existing wiring systems, color coding shall conform to the existing wiring system.

2.2 SPLICES AND JOINTS

- A. In accordance with UL 486A, C, D, E, and NEC.
- B. Aboveground Circuits (No. 10 AWG and smaller):
 1. Connectors: Solderless, screw-on, reusable pressure cable type, rated 600 V, 220° F [105° C], with integral insulation, approved for copper and aluminum conductors.
 2. The integral insulator shall have a skirt to completely cover the stripped wires.
 3. The number, size, and combination of conductors, as listed on the manufacturer's packaging, shall be strictly followed.

C. Aboveground Circuits (No. 8 AWG and larger):

1. Connectors shall be indent, hex screw, or bolt clamp-type of high conductivity and corrosion-resistant material, listed for use with copper and aluminum conductors.
2. Field-installed compression connectors for cable sizes 250 kcmil and larger shall have not fewer than two clamping elements or compression indents per wire.
3. Insulate splices and joints with materials approved for the particular use, location, voltage, and temperature. Splice and joint insulation level shall be not less than the insulation level of the conductors being joined.
4. Plastic electrical insulating tape: Per ASTM D2304, flame-retardant, cold and weather resistant.

2.3 CONTROL WIRING

- A. Unless otherwise specified elsewhere in these specifications, control wiring shall be as specified for power and lighting wiring, except that the minimum size shall be not less than No. 14 AWG.
- B. Control wiring shall be large enough such that the voltage drop under in-rush conditions does not adversely affect operation of the controls.

2.4 WIRE LUBRICATING COMPOUND

- A. Lubricating compound shall be suitable for the wire insulation and conduit, and shall not harden or become adhesive.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install in accordance with the NEC, and as specified.
- B. Install all wiring in raceway systems.
- C. Splice cables and wires only in outlet boxes, junction boxes, pull-boxes, manholes, or handholes.
- D. Wires of different systems (e.g., 120 V, 277 V) shall not be installed in the same conduit or junction box system.
- E. Install cable supports for all vertical feeders in accordance with the NEC. Provide split wedge type which firmly clamps each individual cable and tightens due to cable weight.
- F. For panel boards, cabinets, wireways, switches, and equipment assemblies, neatly form, train, and tie the cables in individual circuits.
- G. Seal cable and wire entering a building from underground between the wire and conduit where the cable exits the conduit, with a non-hardening approved compound.

H. Wire Pulling:

1. Provide installation equipment that will prevent the cutting or abrasion of insulation during pulling of cables. Use lubricants approved for the cable.
2. Use nonmetallic ropes for pulling feeders.
3. Attach pulling lines for feeders by means of either woven basket grips or pulling eyes attached directly to the conductors, as approved by the COR.
4. All cables in a single conduit shall be pulled simultaneously.
5. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

- I. No more than three single-phase branch circuits shall be installed in any one conduit.

3.2 SPLICE INSTALLATION

- A. Splices and terminations shall be mechanically and electrically secure.
- B. Tighten electrical connectors and terminals according to manufacturer's published torque values.
- C. Where the Government determines that unsatisfactory splices or terminations have been installed, remove the devices and install approved devices at no additional cost to the Government.

3.3 FEEDER IDENTIFICATION

- A. In each interior pull-box and junction box, install metal tags on all circuit cables and wires to clearly designate their circuit identification and voltage. The tags shall be the embossed brass type, 1.5 in [40 mm] in diameter and 40 mils thick. Attach tags with plastic ties.

3.4 EXISTING WIRING

Unless specifically indicated on the plans, existing wiring shall not be reused for a new installation.

3.5 CONTROL AND SIGNAL WIRING INSTALLATION

- A. Unless otherwise specified in other sections, install wiring and connect to equipment/devices to perform the required functions as shown and specified.
- B. Except where otherwise required, install a separate power supply circuit for each system so that malfunctions in any system will not affect other systems.

- C. Where separate power supply circuits are not shown, connect the systems to the nearest panel boards of suitable voltages, which are intended to supply such systems and have suitable spare circuit breakers or space for installation.

3.6 CONTROL AND SIGNAL SYSTEM WIRING IDENTIFICATION

- A. Install a permanent wire marker on each wire at each termination.
- B. Identifying numbers and letters on the wire markers shall correspond to those on the wiring diagrams used for installing the systems.
- C. Wire markers shall retain their markings after cleaning.

3.7 ACCEPTANCE CHECKS AND TESTS

- A. Feeders and branch circuits shall have their insulation tested after installation and before connection to utilization devices, such as fixtures, motors, or appliances. Test each conductor with respect to adjacent conductors and to ground. Existing conductors to be reused shall also be tested.
- B. Applied voltage shall be 500VDC for 300-volt rated cable, and 1000VDC for 600-volt rated cable. Apply test for one minute or until reading is constant for 15 seconds, whichever is longer. Minimum insulation resistance values shall not be less than 25 megohms for 300-volt rated cable and 100 megohms for 600-volt rated cable.
- C. Perform phase rotation test on all three-phase circuits.
- D. The contractor shall furnish the instruments, materials, and labor for all tests.

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SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the general grounding and bonding requirements for electrical equipment and operations to provide a low impedance path for possible ground fault currents.
- B. "Grounding electrode system" refers to all electrodes required by NEC, as well as made, supplementary, and lightning protection system grounding electrodes.
- C. The terms "connect" and "bond" are used interchangeably in this specification and have the same meaning.

1.2 RELATED WORK

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.
- B. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Low Voltage power and lighting wiring.
- C. Section 26 22 00, LOW-VOLTAGE TRANSFORMERS: Low voltage transformers.
- D. Section 26 24 16, PANELBOARDS: Low voltage panelboards.

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. Shop Drawings:
 - 1. Clearly present enough information to determine compliance with drawings and specifications.
 - 2. Include the location of system grounding electrode connections and the routing of aboveground and underground grounding electrode conductors.
- C. Test Reports: Provide certified test reports of ground resistance.
- D. Certifications: Two weeks prior to final inspection, submit four copies of the following to the COR:
 - 1. Certification that the materials and installation are in accordance with the drawings and specifications.

2. Certification by the contractor that the complete installation has been properly installed and tested.

1.5 APPLICABLE PUBLICATIONS

Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.

- A. American Society for Testing and Materials (ASTM):
- B1-07.....Standard Specification for Hard-Drawn Copper Wire
- B3-07.....Standard Specification for Soft or Annealed Copper Wire
- B8-04.....Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
- B. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
- 81-1983.....IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
- C2-07.....National Electrical Safety Code
- C. National Fire Protection Association (NFPA):
- 70-11.....National Electrical Code (NEC)
- 99-2005.....Health Care Facilities
- D. Underwriters Laboratories, Inc. (UL):
- 44-05Thermoset-Insulated Wires and Cables
- 83-08Thermoplastic-Insulated Wires and Cables
- 467-07Grounding and Bonding Equipment
- 486A-486B-03Wire Connectors

PART 2 - PRODUCTS

2.1 GROUNDING AND BONDING CONDUCTORS

- A. Equipment grounding conductors shall be UL 44 or UL 83 insulated stranded copper, except that sizes No. 10 AWG [6 mm²] and smaller shall be solid copper. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes No. 4 AWG [25 mm²] and larger shall be identified per NEC.
- B. Bonding conductors shall be ASTM B8 bare stranded copper, except that sizes No. 10 AWG [6 mm²] and smaller shall be ASTM B1 solid bare copper wire.

- C. Conductor sizes shall not be less than shown on the drawings, or not less than required by the NEC, whichever is greater.

2.2 GROUND CONNECTIONS

A. Above Grade:

1. Bonding Jumpers: Compression-type connectors, using zinc-plated fasteners and external tooth lockwashers.
2. Connection to Building Steel: Exothermic-welded type connectors.
3. Ground Busbars: Two-hole compression type lugs, using tin-plated copper or copper alloy bolts and nuts.
4. Rack and Cabinet Ground Bars: One-hole compression-type lugs, using zinc-plated or copper alloy fasteners.

2.3 EQUIPMENT RACK AND CABINET GROUND BARS

Provide solid copper ground bars designed for mounting on the framework of open or cabinet-enclosed equipment racks with minimum dimensions of 0.375 in [4 mm] thick x 0.75 in [19 mm] wide.

2.4 GROUND TERMINAL BLOCKS

At any equipment mounting location (e.g., backboards and hinged cover enclosures) where rack-type ground bars cannot be mounted, provide screw lug-type terminal blocks.

2.5 GROUNDING BUS

Pre-drilled rectangular copper bar with stand-off insulators, minimum 0.25 in [6.3 mm] thick x 4 in [100 mm] high in cross-section, length as shown on drawings, with 0.281 in [7.1 mm] holes spaced 1.125 in [28 mm] apart.

PART 3 - EXECUTION

3.1 GENERAL

- A. Ground in accordance with the NEC, as shown on drawings, and as specified herein.
- B. System Grounding:
 1. Secondary service neutrals: Ground at the supply side of the secondary disconnecting means and at the related transformers.
 2. Separately derived systems (transformers downstream from the service entrance): Ground the secondary neutral.
- C. Equipment Grounding: Metallic structures, including ductwork and building steel, enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits, shall be bonded and grounded.

3.2 INACCESSIBLE GROUNDING CONNECTIONS

Make grounding connections, which are normally buried or otherwise inaccessible (except connections for which access for periodic testing is required), by exothermic weld.

3.3 SECONDARY VOLTAGE EQUIPMENT AND CIRCUITS

- A. Main Bonding Jumper: Bond the secondary service neutral to the ground bus in the service equipment.
- B. Metallic Piping, Building Steel, and Supplemental Electrode(s):
 - 1. Provide a grounding electrode conductor sized per NEC between the service equipment ground bus and all metallic water pipe systems, building steel, and supplemental or made electrodes. Provide jumper insulating joints in the metallic piping. All connections to electrodes shall be made with fittings that conform to UL 467.
 - 2. Provide a supplemental ground electrode and bond to the grounding electrode system.
- C. Panelboards:
 - 1. Connect the various feeder equipment grounding conductors to the ground bus in the enclosure with suitable pressure connectors.
 - 2. For service entrance equipment, connect the grounding electrode conductor to the ground bus.
 - 3. Provide ground bars, bolted to the housing, with sufficient lugs to terminate the equipment grounding conductors.
 - 4. Connect metallic conduits that terminate without mechanical connection to the housing, by grounding bushings and grounding conductor to the equipment ground bus.

3.4 RACEWAY

- A. Conduit Systems:
 - 1. Ground all metallic conduit systems. All metallic conduit systems shall contain an equipment grounding conductor.
 - 2. Non-metallic conduit systems, except non-metallic feeder conduits that carry a grounded conductor from exterior transformers to interior or building-mounted service entrance equipment, shall contain an equipment grounding conductor.
 - 3. Conduit that only contains a grounding conductor, and is provided for its mechanical protection, shall be bonded to that conductor at the entrance and exit from the conduit.

4. Metallic conduits which terminate without mechanical connection to an electrical equipment housing by means of locknut and bushings or adapters, shall be provided with grounding bushings. Connect bushings with a bare grounding conductor to the equipment ground bus.
- B. Feeders and Branch Circuits: Install equipment grounding conductors with all feeders and power and lighting branch circuits.
- C. Boxes, Cabinets, Enclosures, and Panelboards:
 1. Bond the equipment grounding conductor to each pullbox, junction box, outlet box, device box, cabinets, and other enclosures through which the conductor passes (except for special grounding systems for intensive care units and other critical units shown).
 2. Provide lugs in each box and enclosure for equipment grounding conductor termination.
- D. Wireway Systems:
 1. Bond the metallic structures of wireway to provide 100% electrical continuity throughout the wireway system, by connecting a No. 6 AWG [16 mm²] bonding jumper at all intermediate metallic enclosures and across all section junctions.
 2. Install insulated No. 6 AWG [16 mm²] bonding jumpers between the wireway system, bonded as required above, and the closest building ground at each end and approximately every 50 ft [16 M].
 3. Use insulated No. 6 AWG [16 mm²] bonding jumpers to ground or bond metallic wireway at each end for all intermediate metallic enclosures and across all section junctions.
 4. Use insulated No. 6 AWG [16 mm²] bonding jumpers to ground cable tray to column-mounted building ground plates (pads) at each end and approximately every 49 ft [15 M].
- E. Receptacles shall not be grounded through their mounting screws. Ground receptacles with a jumper from the receptacle green ground terminal to the device box ground screw and a jumper to the branch circuit equipment grounding conductor.
- F. Ground lighting fixtures to the equipment grounding conductor of the wiring system when the green ground is provided; otherwise, ground the fixtures through the conduit systems. Fixtures connected with flexible conduit shall have a green ground wire included with the power wires from the fixture through the flexible conduit to the first outlet box.

- G. Fixed electrical appliances and equipment shall be provided with a ground lug for termination of the equipment grounding conductor.

3.5 CORROSION INHIBITORS

When making ground and ground bonding connections, apply a corrosion inhibitor to all contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between the metals used.

3.6 CONDUCTIVE PIPING

- A. Bond all conductive piping systems, interior and exterior, to the grounding electrode system. Bonding connections shall be made as close as practical to the equipment ground bus.

3.7 ELECTRICAL ROOM GROUNDING

Building Earth Ground Busbars: Verify and provide as required a ground busbar and mounting hardware at each project-related electrical room and connect to pigtail extensions of the building grounding ring.

3.8 GROUND RESISTANCE

- A. Grounding system resistance to ground shall not exceed 5 ohms. Make any modifications or additions to the grounding electrode system necessary for compliance without additional cost to the Government. Final tests shall ensure that this requirement is met.
- B. Resistance of the grounding electrode system shall be measured using a four-terminal fall-of-potential method as defined in IEEE 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not fewer than 48 hours after the last rainfall. The combined resistance of separate systems may be used to meet the required resistance.

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SECTION 26 05 33
RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing, installation, and connection of conduit, fittings, and boxes, to form complete, coordinated, grounded raceway systems. Raceways are required for all wiring unless shown or specified otherwise.
- B. Definitions: The term conduit, as used in this specification, shall mean any or all of the raceway types specified.

1.2 RELATED WORK

- A. Section 07 84 00, FIRESTOPPING: Sealing around penetrations to maintain the integrity of fire rated construction.
- B. Section 07 92 00, JOINT SEALANTS: Sealing around conduit penetrations through the building envelope to prevent moisture migration into the building.
- C. Section 09 91 00, PAINTING: Identification and painting of conduit and other devices.
- D. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.
- E. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:

- A. Manufacturer's Literature and Data: Showing each cable type and rating. The specific item proposed and its area of application shall be identified on the catalog cuts.
- B. Shop Drawings:
 - 1. Size and location of main feeders.
 - 2. Size and location of panels and pull-boxes.
 - 3. Layout of required conduit penetrations through structural elements.

C. Certifications:

1. Two weeks prior to the final inspection, submit four copies of the following certifications to the COR:
 - a. Certification by the manufacturer that the material conforms to the requirements of the drawings and specifications.
 - b. Certification by the contractor that the material has been properly installed.

1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. American National Standards Institute (ANSI):
 - C80.1-05.....Electrical Rigid Steel Conduit
 - C80.3-05.....Steel Electrical Metal Tubing
 - C80.6-05.....Electrical Intermediate Metal Conduit
- C. National Fire Protection Association (NFPA):
 - 70-11.....National Electrical Code (NEC)
- D. Underwriters Laboratories, Inc. (UL):
 - 1-05.....Flexible Metal Conduit
 - 5-04.....Surface Metal Raceway and Fittings
 - 6-07.....Electrical Rigid Metal Conduit - Steel
 - 50-95.....Enclosures for Electrical Equipment
 - 360-093.....Liquid-Tight Flexible Steel Conduit
 - 467-07.....Grounding and Bonding Equipment
 - 514A-04.....Metallic Outlet Boxes
 - 514B-04.....Conduit, Tubing, and Cable Fittings
 - 514C-96.....Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers
 - 651-05.....Schedule 40 and 80 Rigid PVC Conduit and Fittings
 - 651A-00.....Type EB and A Rigid PVC Conduit and HDPE Conduit
 - 797-07.....Electrical Metallic Tubing
 - 1242-06.....Electrical Intermediate Metal Conduit - Steel
- E. National Electrical Manufacturers Association (NEMA):
 - TC-2-03.....Electrical Polyvinyl Chloride (PVC) Tubing and Conduit
 - TC-3-04.....PVC Fittings for Use with Rigid PVC Conduit and Tubing

FB1-07.....Fittings, Cast Metal Boxes and Conduit Bodies
for Conduit, Electrical Metallic Tubing and
Cable

PART 2 - PRODUCTS

2.1 MATERIAL

- A. Conduit Size: In accordance with the NEC, but not less than 0.5 in [13 mm] unless otherwise shown. Where permitted by the NEC, 0.5 in [13 mm] flexible steel conduit may be used for tap connections not exceeding five feet in length with a separate ground wire to recessed lighting fixtures.
- B. Conduit:
 - 1. Rigid steel: Shall conform to UL 6 and ANSI C80.1.
 - 2. Rigid intermediate steel conduit (IMC): Shall conform to UL 1242 and ANSI C80.6.
 - 3. Electrical metallic tubing (EMT): Shall conform to UL 797 and ANSI C80.3. Maximum size not to exceed 4 in [105 mm] and shall be permitted only with cable rated 600 V or less.
 - 4. Liquid-tight flexible metal conduit: Shall conform to UL 360.
 - 5. Surface metal raceway: Shall conform to UL 5.
- C. Conduit Fittings:
 - 1. Rigid steel and IMC conduit fittings:
 - a. Fittings shall meet the requirements of UL 514B and NEMA FB1.
 - b. Standard threaded couplings, locknuts, bushings, conduit bodies, and elbows: Only steel or malleable iron materials are acceptable. Integral retractable type IMC couplings are also acceptable.
 - c. Locknuts: Bonding type with sharp edges for digging into the metal wall of an enclosure.
 - d. Bushings: Metallic insulating type, consisting of an insulating insert, molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted.
 - e. Erickson (union-type) and set screw type couplings: Approved for use in concrete are permitted for use to complete a conduit run where conduit is installed in concrete. Use set screws of case-hardened steel with hex head and cup point to firmly seat in conduit wall for positive ground. Tightening of set screws with pliers is prohibited.

- f. Sealing fittings: Threaded cast iron type. Use continuous drain-type sealing fittings to prevent passage of water vapor. In concealed work, install fittings in flush steel boxes with blank cover plates having the same finishes as that of other electrical plates in the room.
- 2. Electrical metallic tubing fittings:
 - a. Fittings and conduit bodies shall meet the requirements of UL 514B, ANSI C80.3, and NEMA FB1.
 - b. Only steel or malleable iron materials are acceptable.
 - c. Compression couplings and connectors: Concrete-tight and rain-tight, with connectors having insulated throats.
 - d. Indent-type connectors or couplings are prohibited.
 - e. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are prohibited.
- 3. Flexible steel conduit fittings:
 - a. Conform to UL 514B. Only steel or malleable iron materials are acceptable.
 - b. Clamp-type, with insulated throat.
- 4. Liquid-tight flexible metal conduit fittings:
 - a. Fittings shall meet the requirements of UL 514B and NEMA FB1.
 - b. Only steel or malleable iron materials are acceptable.
 - c. Fittings must incorporate a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening. Connectors shall have insulated throats.
- 5. Surface metal raceway fittings: As recommended by the raceway manufacturer. Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, conduit entry fittings, accessories, and other fittings as required for complete system.
- 6. Expansion and deflection couplings:
 - a. Conform to UL 467 and UL 514B.
 - b. Accommodate a 0.75 in [19 mm] deflection, expansion, or contraction in any direction, and allow 30 degree angular deflections.
 - c. Include internal flexible metal braid, sized to guarantee conduit ground continuity and a low-impedance path for fault currents, in accordance with UL 467 and the NEC tables for equipment grounding conductors.
 - d. Jacket: Flexible, corrosion-resistant, watertight, moisture and heat-resistant molded rubber material with stainless steel jacket clamps.

D. Conduit Supports:

1. Parts and hardware: Zinc-coat or provide equivalent corrosion protection.
2. Individual Conduit Hangers: Designed for the purpose, having a pre-assembled closure bolt and nut, and provisions for receiving a hanger rod.
3. Multiple conduit (trapeze) hangers: Not less than 1.5 x 1.5 in [38 mm x 38 mm], 12-gauge steel, cold-formed, lipped channels; with not less than 0.375 in [9 mm] diameter steel hanger rods.
4. Solid Masonry and Concrete Anchors: Self-drilling expansion shields, or machine bolt expansion.

E. Outlet, Junction, and Pull Boxes:

1. UL-50 and UL-514A.
2. Cast metal where required by the NEC or shown, and equipped with rustproof boxes.
3. Sheet metal boxes: Galvanized steel, except where otherwise shown.
4. Flush-mounted wall or ceiling boxes shall be installed with raised covers so that the front face of raised cover is flush with the wall. Surface-mounted wall or ceiling boxes shall be installed with surface-style flat or raised covers.

F. Wireways: Equip with hinged covers, except where removable covers are shown. Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for a complete system.

PART 3 - EXECUTION**3.1 PENETRATIONS****A. Cutting or Holes:**

1. Cut holes in advance where they should be placed in the structural elements, such as ribs or beams. Obtain the approval of the COR prior to drilling through structural elements.
2. Cut holes through concrete and masonry in new and existing structures with a diamond core drill or concrete saw. Pneumatic hammers, impact electric, hand, or manual hammer-type drills are not allowed, except where permitted by the COR as required by limited working space.

B. Firestop: Where conduits, wireways, and other electrical raceways pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases as specified in Section 07 84 00, FIRESTOPPING.

- C. Waterproofing: At floor, exterior wall, and roof conduit penetrations, completely seal clearances around the conduit and make watertight, as specified in Section 07 92 00, JOINT SEALANTS.

3.2 INSTALLATION, GENERAL

- A. In accordance with UL, NEC, as shown, and as specified herein.
- B. Essential (Emergency) raceway systems shall be entirely independent of other raceway systems, except where shown on drawings.
- C. Install conduit as follows:
1. In complete mechanically and electrically continuous runs before pulling in cables or wires.
 2. Unless otherwise indicated on the drawings or specified herein, installation of all conduits shall be concealed within finished walls, floors, and ceilings.
 3. Flattened, dented, or deformed conduit is not permitted. Remove and replace the damaged conduits with new undamaged material.
 4. Assure conduit installation does not encroach into the ceiling height head room, walkways, or doorways.
 5. Cut square, ream, remove burrs, and draw up tight.
 6. Independently support conduit at 8 ft [2.4 M] on centers. Do not use other supports, i.e., suspended ceilings, suspended ceiling supporting members, lighting fixtures, conduits, mechanical piping, or mechanical ducts.
 7. Support within 12 in [300 mm] of changes of direction, and within 12 in [300 mm] of each enclosure to which connected.
 8. Close ends of empty conduit with plugs or caps at the rough-in stage until wires are pulled in, to prevent entry of debris.
 9. Conduit installations under fume and vent hoods are prohibited.
 10. Secure conduits to cabinets, junction boxes, pull-boxes, and outlet boxes with bonding type locknuts. For rigid and IMC conduit installations, provide a locknut on the inside of the enclosure, made up wrench tight. Do not make conduit connections to junction box covers.
 11. Flashing of penetrations of the roof membrane is specified in Section 07 60 00, FLASHING AND SHEET METAL.
 12. Conduit bodies shall only be used for changes in direction, and shall not contain splices.
- D. Conduit Bends:
1. Make bends with standard conduit bending machines.
 2. Conduit hickey may be used for slight offsets and for straightening stubbed out conduits.

3. Bending of conduits with a pipe tee or vise is prohibited.

E. Layout and Homeruns:

1. Install conduit with wiring, including homeruns, as shown on drawings.
2. Deviations: Make only where necessary to avoid interferences and only after drawings showing the proposed deviations have been submitted approved by the COR.

3.3 CONCEALED WORK INSTALLATION

A. Above Furred or Suspended Ceilings and in Walls:

1. Conduit for conductors 600 V and below: Rigid steel, IMC, or EMT. Mixing different types of conduits indiscriminately in the same system is prohibited.
2. Align and run conduit parallel or perpendicular to the building lines.
3. Connect recessed lighting fixtures to conduit runs with maximum 6 ft [1.8 M] of flexible metal conduit extending from a junction box to the fixture.
4. Tightening setscrews with pliers is prohibited.

3.4 EXPOSED WORK INSTALLATION

- A. Unless otherwise indicated on the drawings, exposed conduit is only permitted in mechanical and electrical rooms.
- B. Conduit for Conductors 600 V and Below: Rigid steel, IMC, or EMT. Mixing different types of conduits indiscriminately in the system is prohibited.
- C. Align and run conduit parallel or perpendicular to the building lines.
- D. Install horizontal runs close to the ceiling or beams and secure with conduit straps.
- E. Support horizontal or vertical runs at not over 8 ft [2.4 M] intervals.
- F. Surface metal raceways: Use only where shown.
- G. Painting:
 1. Paint exposed conduit as specified in Section 09 91 00, PAINTING.
 2. Paint all conduits containing cables rated over 600 V safety orange. Refer to Section 09 91 00, PAINTING for preparation, paint type, and exact color. In addition, paint legends, using 2 in [50 mm] high black numerals and letters, showing the cable voltage rating. Provide legends where conduits pass through walls and floors and at maximum 20 ft [6 M] intervals in between.

3.5 WET OR DAMP LOCATIONS

- A. Unless otherwise shown, use conduits of rigid steel or IMC.
- B. Provide sealing fittings to prevent passage of water vapor where conduits pass from warm to cold locations, i.e., refrigerated spaces, constant-temperature rooms, air-conditioned spaces, building exterior walls, roofs, or similar spaces.
- C. Unless otherwise shown, use rigid steel or IMC conduit within 5 ft [1.5 M] of the exterior and below concrete building slabs in contact with soil, gravel, or vapor barriers. Conduit shall be half-lapped with 10 mil PVC tape before installation. After installation, completely recoat or retape any damaged areas of coating.

3.6 MOTORS AND VIBRATING EQUIPMENT

- A. Use flexible metal conduit for connections to motors and other electrical equipment subject to movement, vibration, misalignment, cramped quarters, or noise transmission.
- B. Use liquid-tight flexible metal conduit for installation in exterior locations, moisture or humidity laden atmosphere, corrosive atmosphere, water or spray wash-down operations, inside airstream of HVAC units, and locations subject to seepage or dripping of oil, grease, or water. Provide a green equipment grounding conductor with flexible metal conduit.

3.7 EXPANSION JOINTS

- A. Conduits 3 in [75 mm] and larger that are secured to the building structure on opposite sides of a building expansion joint require expansion and deflection couplings. Install the couplings in accordance with the manufacturer's recommendations.
- B. Provide conduits smaller than 3 in [75 mm] with junction boxes on both sides of the expansion joint. Connect conduits to junction boxes with sufficient slack of flexible conduit to produce 5 in [125 mm] vertical drop midway between the ends. Flexible conduit shall have a bonding jumper installed. In lieu of this flexible conduit, expansion and deflection couplings as specified above for conduits 15 in [375 mm] and larger are acceptable.
- C. Install expansion and deflection couplings where shown.

3.8 CONDUIT SUPPORTS, INSTALLATION

- A. Safe working load shall not exceed one-quarter of proof test load of fastening devices.
- B. Use pipe straps or individual conduit hangers for supporting individual conduits.

- C. Support multiple conduit runs with trapeze hangers. Use trapeze hangers that are designed to support a load equal to or greater than the sum of the weights of the conduits, wires, hanger itself, and 200 lbs [90 kg]. Attach each conduit with U-bolts or other approved fasteners.
- D. Support conduit independently of junction boxes, pull-boxes, fixtures, suspended ceiling T-bars, angle supports, and similar items.
- E. Fasteners and Supports in Solid Masonry and Concrete:
 - 1. New Construction: Use steel or malleable iron concrete inserts set in place prior to placing the concrete.
 - 2. Existing Construction:
 - a. Steel expansion anchors not less than 0.25 in [6 mm] bolt size and not less than 1.125 in [28 mm] embedment.
 - b. Power set fasteners not less than 0.25 in [6 mm] diameter with depth of penetration not less than 3 in [75 mm].
 - c. Use vibration and shock-resistant anchors and fasteners for attaching to concrete ceilings.
- F. Hollow Masonry: Toggle bolts.
- G. Bolts supported only by plaster or gypsum wallboard are not acceptable.
- H. Metal Structures: Use machine screw fasteners or other devices specifically designed and approved for the application.
- I. Attachment by wood plugs, rawl plug, plastic, lead or soft metal anchors, or wood blocking and bolts supported only by plaster is prohibited.
- J. Chain, wire, or perforated strap shall not be used to support or fasten conduit.
- K. Spring steel type supports or fasteners are prohibited for all uses except horizontal and vertical supports/fasteners within walls.
- L. Vertical Supports: Vertical conduit runs shall have riser clamps and supports in accordance with the NEC and as shown. Provide supports for cable and wire with fittings that include internal wedges and retaining collars.

3.9 BOX INSTALLATION

- A. Boxes for Concealed Conduits:
 - 1. Flush-mounted.
 - 2. Provide raised covers for boxes to suit the wall or ceiling, construction, and finish.
- B. In addition to boxes shown, install additional boxes where needed to prevent damage to cables and wires during pulling-in operations.

- C. Remove only knockouts as required and plug unused openings. Use threaded plugs for cast metal boxes and snap-in metal covers for sheet metal boxes.
- D. Outlet boxes mounted back-to-back in the same wall are prohibited. A minimum 24 in [600 mm] center-to-center lateral spacing shall be maintained between boxes.
- E. Minimum size of outlet boxes for ground fault interrupter (GFI) receptacles is 4 in [100 mm] square x 2.125 in [55 mm] deep, with device covers for the wall material and thickness involved.
- F. Stencil or install phenolic nameplates on covers of the boxes identified on riser diagrams; for example "SIG-FA JB No. 1."
- G. On all branch circuit junction box covers, identify the circuits with black marker.

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SECTION 26 05 71
ELECTRICAL SYSTEM PROTECTIVE DEVICE STUDY

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the requirements of the Electrical System Protective Device Study (herein, "the study").
- B. A short-circuit and selective coordination study shall be prepared for the electrical overcurrent devices to be installed under this project.
- C. The study shall present an organized time-current analysis of each protective device in series from the individual device back to the utility and the on-site generator sources. The study shall reflect the operation of each device during normal and abnormal current conditions.

1.2 RELATED WORK

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements that are common to more than one section of Division 26.
- B. Section 26 24 16, PANEL BOARDS: Low-voltage panelboards.

1.3 QUALITY ASSURANCE

- A. Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. The protective device study shall be prepared by the equipment manufacturer's qualified engineers or an approved consultant. The contractor is responsible for providing all pertinent information required by the preparers to complete the study.

1.4 SUBMITTALS

- A. In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:
- B. Product data on the software program to be used for the study. Software shall be in mainstream use in the industry, shall provide device settings and ratings, and shall show selective coordination by time-current drawings.
- C. Complete short-circuit and coordination study as described in paragraph 1.6.
- D. Protective equipment shop drawings shall be submitted simultaneously with or after the protective device study. Protective equipment shop drawings will not be accepted prior to protective device study.

- E. Certification: Two weeks prior to final inspection, submit four copies of the following to the COR:

Certification by the contractor that the protective devices have been adjusted and set in accordance with the approved protective device study.

1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. National Fire Protection Association (NFPA):
70-11.....National Electrical Code (NEC)
- C. Institute of Electrical and Electronics Engineers (IEEE):
242-01.....Recommended Practice for Protection and
Coordination of Industrial and Commercial Power
Systems
399-97.....Recommended Practice for Power Systems Analysis
1584a-04.....Guide for Performing Arc-Flash Hazard
Calculations

1.6 REQUIREMENTS

- A. The complete study shall include a system one line diagram, short-circuit and ground fault analysis, and protective coordination plots for all overcurrent protective devices installed under this project.
- B. One Line Diagram:
1. On the one line diagram, show all electrical equipment and wiring to be protected by the overcurrent devices installed under this project.
 2. On the one line diagram, also show the following specific information:
 - a. Calculated fault impedance, X/R ratios, and short-circuit values at each feeder and branch circuit bus.
 - b. Breaker and fuse ratings.
 - c. Generator kW and Transformer kVA and voltage ratings, percent impedance, X/R ratios, and wiring connections.
 - d. Voltage at each bus.
 - e. Identification of each bus, matching the identification on the construction drawings.
 - f. Conduit, cable, and busway material and sizes, length, and X/R ratios.

C. Short-Circuit Study:

1. Systematically calculate the fault impedance to determine the available short-circuit and ground fault currents at each bus. Incorporate the motor contribution in determining the momentary and interrupting ratings of the protective devices.
2. The study shall be calculated by means of a computer program. Pertinent data and the rationale employed in developing the calculations shall be incorporated in the introductory remarks of the study.
3. Present the data conclusions of the short-circuit study in a table format. Include the following:
 - a. Device identification.
 - b. Operating voltage.
 - c. Protective device.
 - d. Device rating.
 - e. Calculated short-circuit current.

D. Coordination Curves:

1. Prepare the coordination curves to determine the required settings of protective devices to ensure selective coordination. Graphically illustrate on log-log paper that adequate time separation exists between series devices, including the utility company upstream device. Plot the specific time-current characteristics of each protective device in such a manner that all upstream devices are clearly depicted on one sheet.
2. The following specific information shall also be shown on the coordination curves:
 - a. Device identification.
 - b. Voltage and current ratio for curves.
 - c. 3-phase and 1-phase ANSI damage points for each transformer.
 - d. No-damage, melting, and clearing curves for fuses.
 - e. Cable damage curves.
 - f. Transformer in-rush points.
 - g. Maximum short-circuit cutoff point.
3. Develop a table to summarize the settings selected for the protective devices. Include the following in the table:
 - a. Device identification.
 - b. Relay CT ratios, tap, time dial, and instantaneous pickup.
 - c. Circuit breaker sensor rating, long-time, short-time, and instantaneous settings, and time bands.
 - d. Fuse rating and type.

e. Ground fault pickup and time delay.

1.7 ANALYSIS

- A. Analyze the short-circuit calculations, and highlight any equipment determined to be underrated as specified. Propose approaches to effectively protect the underrated equipment. Provide minor modifications to conform with the study (examples of minor modifications are trip sizes within the same frame, the time-current curve characteristics of induction relays, CT ranges, etc.).
- B. After developing the coordination curves, highlight areas lacking coordination. Present a technical evaluation with a discussion of the logical compromises for best coordination.

1.8 ADJUSTMENTS, SETTINGS AND MODIFICATIONS

- A. Necessary final field adjustments, settings, and minor modifications shall be made to conform with the study without additional cost to the Government.
- B. All final circuit breaker and relay settings and fuse sizes shall be made in accordance with the recommendations of the study.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

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**SECTION 26 09 23
LIGHTING CONTROLS**

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies the furnishing, installation and connection of the lighting controls.

1.2 RELATED WORK

- A. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC: Interface of lighting controls with HVAC control systems.
- B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General requirements that are common to more than one section of Division 26.
- C. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Cables and wiring.
- D. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path to ground for possible ground fault currents.
- E. Section 26 27 26, WIRING DEVICES: Wiring devices used for control of the lighting systems.

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:
- B. Product Data: For each type of lighting control, submit the following information.
 - 1. Manufacturer's catalog data.
 - 2. Wiring schematic and connection diagram.
 - 3. Installation details.
- C. Manuals:
 - 1. Submit, simultaneously with the shop drawings companion copies of complete maintenance and operating manuals including technical data sheets, and information for ordering replacement parts.
 - 2. Two weeks prior to the final inspection, submit four copies of the final updated maintenance and operating manuals, including any changes, to the COR.

D. Certifications:

1. Two weeks prior to final inspection, submit four copies of the following certifications to the COR:
 - a. Certification by the Contractor that the equipment has been properly installed, adjusted, and tested.

1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. Green Seal (GS):
 - GC-12.....Occupancy Sensors
- C. Illuminating Engineering Society of North America (IESNA):
 - IESNA LM-48Guide for Calibration of Photoelectric Control Devices
- D. National Fire Protection Association (NFPA):
 - 70-11 National Electrical Code (NEC)
- E. National Electrical Manufacturer's Association (NEMA)
 - C136.10.....American National Standard for Roadway Lighting Equipment-Locking-Type Photocontrol Devices and Mating Receptacles - Physical and Electrical Interchangeability and Testing
 - ICS-1.....Standard for Industrial Control and Systems General Requirements
 - ICS-2.....Standard for Industrial Control and Systems: Controllers, Contractors, and Overload Relays Rated Not More than 2000 Volts AC or 750 Volts DC: Part 8 - Disconnect Devices for Use in Industrial Control Equipment
 - ICS-6.....Standard for Industrial Controls and Systems Enclosures
- F. Underwriters Laboratories, Inc. (UL):
 - 20.....Standard for General-Use Snap Switches
 - 773.....Standard for Plug-In Locking Type Photocontrols for Use with Area Lighting
 - 773ANonindustrial Photoelectric Switches for Lighting Control
 - 98.....Enclosed and Dead-Front Switches
 - 917.....Clock Operated Switches

PART 2 - PRODUCTS

2.1 TIMER SWITCHES

- A. Digital switches with backlit LCD display, 120/277 volt rated, fitting as a replacement for standard wall switches.
 - 1. Compatibility: Compatible with all ballasts.
 - 2. Warning: Audible warning to sound during the last minute of "on" operation.
 - 3. Time-out: Adjustable from 5 minutes to 12 hours.
 - 4. Faceplate: Refer to wall plate material and color requirements for toggle switches, as specified in Section 26 27 26, WIRING DEVICES.

2.2 CEILING-MOUNTED PHOTOELECTRIC SWITCHES

- A. Solid-state, light-level sensor unit, with separate relay unit.
 - 1. Sensor Output: Contacts rated to operate the associated relay. Sensor shall be powered from the relay unit.
 - 2. Relay Unit: Dry contacts rated for 20A ballast load at 120V and 277V, for 13A tungsten at 120V, and for 1 hp at 120V.
 - 3. Monitoring Range: 10 to 200 fc [108 to 2152 lx], with an adjustment for turn-on and turn-off levels.
 - 4. Time Delay: Adjustable from 5 to 300 seconds, with deadband adjustment.
 - 5. Indicator: Two LEDs to indicate the beginning of on-off cycles.

2.3 INDOOR OCCUPANCY SENSORS - LINE VOLTAGE

- A. Wall- or ceiling-mounting, solid-state units with a power supply and relay unit, suitable for the environmental conditions in which installed.
 - 1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a 1 to 15 minute adjustable time delay for turning lights off.
 - 2. Sensor Output: Contacts rated to operate the connected relay. Sensor shall be powered from the relay unit.
 - 3. Relay Unit: Dry contacts rated for 20A ballast load at 120V and 277V, for 13A tungsten at 120V, and for 1 hp at 120V.
 - 4. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 - 5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.

6. Bypass Switch: Override the on function in case of sensor failure.
 7. Manual/automatic selector switch.
 8. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc [21.5 to 2152 lx]; keep lighting off when selected lighting level is present.
 9. Faceplate for Wall-Switch Replacement Type: Refer to wall plate material and color requirements for toggle switches, as specified in Section 26 27 26, WIRING DEVICES.
- B. Dual-technology Type: Ceiling mounting; combination PIR and ultrasonic detection methods, field-selectable.
1. Sensitivity Adjustment: Separate for each sensing technology.
 2. Detector Sensitivity: Detect occurrences of 6-inch [150mm] minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. [232 sq. cm], and detect a person of average size and weight moving not less than 12 inches [305 mm] in either a horizontal or a vertical manner at an approximate speed of 12 inches/s [305 mm/s].
 3. Detection Coverage: as scheduled on drawings.
- C. Basis-of-Design Manufacturer Products.
1. Sensor Switch CMR-9 & CMR-9-2P (PIR Ceiling Mount- single and two pole)
 2. Sensor Switch CMR-PDT & CMR-PDT-2P (PIR/Microphonic Ceiling Mount- single and two pole)
 - a. Substitutions: Or equal with similar and salient characteristics. Submit in format noted in VAAR 811.104-71(b) and provide the required information on "equal" products, and to provide descriptive literature in accordance with FAR 52.14-21.
 3. Sensor Switch CMR-10 & CMR-10-2P (PIR Ceiling Mount Extended Range - single and two pole)
 4. Sensor Switch CMR-PDT-10 & CMR-PDT-10-2P (PIR/Microphonic Ceiling Mount Extended Range - single and two pole)
 - a. Substitutions: Or equal with similar and salient characteristics. Submit in format noted in VAAR 811.104-71(b) and provide the required information on "equal" products, and to provide descriptive literature in accordance with FAR 52.14-21.
 5. Sensor Switch WVR-16 & WVR-16-2P (PIR Wall Mount single and two pole)
 6. Sensor Switch WVR-PDT & WVR-PDT-2P (PIR/Microphonic Wall Mount single and two pole)
 7. Sensor Switch HMR-10 (PIR High Bay Aisle Way)
 8. Sensor Switch CMR-6 & CMR-6-SH (High Bay Ceiling)

9. Substitutions: Or equal with similar and salient characteristics.
Submit in format noted in VAAR 811.104-71(b) and provide the required information on "equal" products, and to provide descriptive literature in accordance with FAR 52.14-21.

2.4 INDOOR OCCUPANCY SENSORS - LOW Voltage

- A. For use with Network Lighting Controls.
- B. Wall switch sensors - small areas
 1. Sensor shall recess into single gang switch box and fit a standard GFI opening.
 2. Sensor must meet NEC grounding requirements by providing a dedicated ground connection and grounding to mounting strap. Line and load wire connections shall be interchangeable. Sensor shall not allow current to pass to the load when sensor is in the unoccupied (Off) condition.
 3. Sensor shall use PIR sensing incorporating a nominal one half inch focal length lens viewing 9 inches above and below horizontal view pattern measured at 10 feet.
 4. Sensor shall have optional features for photocell/daylight override, vandal resistant lens, and no switch as specified.
 5. In areas with inboard/outboard switching, sensor shall provide two dedicated relays and override switches. Each relay shall have independent programmable time delays.
 6. In areas with obstructions to the occupant's workspace, sensor shall utilize programmable dual technology PIR/Microphonic sensing.
 7. All models shall have "Reduced Turn On". This is a field programmable function for problematic areas with unforeseen reflective surfaces. False turn on shall be eliminated with this feature.
 8. Basis-of-Design Manufacturer Products.
 - a. Sensor Switch WSD (PIR)
 - b. Sensor Switch WSD-2P (PIR inboard/outboard)
 - c. Sensor Switch WSD-PDT (PIR/Microphonic)
 - d. Sensor Switch Sensor Switch WSD-PDT-2P (PIR/Microphonic inboard/outboard)
 - e. Sensor Switch WSD-SA (PIR Semi-Automatic)
 - f. Sensor Switch WSD-PDT-SA (PIR/Microphonic Semi-Automatic)
 - g. Substitutions: Or equal with similar and salient characteristics.
Submit in format noted in VAAR 811.104-71(b) and provide the required information on "equal" products, and to provide descriptive literature in accordance with FAR 52.14-21.

C. Low voltage sensors

1. Sensors shall operate on a class 2, three-conductor system. Sensors shall operate on 12 to 24 VAC or VDC and consume no more than 5 milliamps so that up to 14 sensors may be connected to a single power pack.
2. Upon initial power up, sensors must immediately turn on. Power packs may be wired on the line or load side of local switching and must not exhibit any delays when switch is energized.
3. In areas with clear line of site view of the workspace, sensors shall use PIR detection. In areas with obstructions, sensors shall use PIR/Microphonic detection.
4. Optional interface with Building Automation System (BAS): Each zone designated shall provide one sensor with a SPDT class 2 relay providing a digital input to BAS. All sensors in designated zone shall communicate to sensor with relay for status to BAS. Sensor relay coil shall energize in the unoccupied state to load share the low voltage current from power pack. Note that Power Pack must be installed on the Line side of the local toggle switch for Relay to work properly.
5. Specific sensors shall have optional feature for photocell/daylight override, and/or Low Temperature/High Humidity environments.
6. Basis-of-Design Manufacturer Products.
 - a. Sensor Switch CM-9 (PIR Ceiling)
 - b. Sensor Switch CM-PDT (PIR/Microphonic Ceiling)
 - c. Sensor Switch CM-10 (PIR Ceiling-Extended Range)
 - d. Sensor Switch CM-PDT-10 (PIR/Microphonic Ceiling-Extended Range)
 - e. Sensor Switch WV-16 (PIR Wall Mount)
 - f. Sensor Switch WV-PDT (PIR/Microphonic Wall Mount)
 - g. Sensor Switch HW-13 (PIR Hallway)
 - h. Sensor Switch HM-10 (PIR High Bay Aisle Way)
 - i. Sensor Switch CM-6 (PIR High Bay)
 - j. Substitutions: Or equal with similar and salient characteristics. Submit in format noted in VAAR 811.104-71(b) and provide the required information on "equal" products, and to provide descriptive literature in accordance with FAR 52.14-21.

D. Power packs

1. Power Packs shall accept 120 or 277 VAC, be plenum rated, and provide class 2 power for up to 14 remote sensors.
2. Power Pack shall securely mount to junction location through a threaded ½ inch chase nipple. Plastic clips into junction box shall

- not be accepted. All class 1 wiring shall pass through chase nipple into adjacent junction box without any exposure of wire leads. Note: UL Listing under Energy Management or Industrial Control Equipment automatically meets this requirement, whereas Appliance Control Listing does not meet this safety requirement.
3. When required by local code, Power Pack must install inside standard electrical enclosure and provide UL recognized support to junction box. All class 1 wiring is to pass through chase nipple into adjacent junction box without any exposure of wire leads.
 4. Power Pack shall incorporate a Class 1 relay and an A/C electronic switching device. The A/C electronic switching device shall make and break the load, while the relay shall carry the current in the On condition. This system shall provide full 20 amp switching of all load types, and be rated for 400,000 cycles.
 5. Power Packs shall be single circuit, or two circuits. Slave Packs may be used to control additional circuits. When two circuit power packs, or slave packs are used, the power packs must be wired directly to circuit breaker. Otherwise, power packs may be wired on the line or load side of the local switch.
 6. Basis-of-Design Manufacturer Products.
 - a. Sensor Switch PP-20 (Single Pole)
 - b. Sensor Switch PP-20-2P (Two Pole)
 - c. Sensor Switch SP-20 (Slave Pack)
 - d. Substitutions: Or equal with similar and salient characteristics. Submit in format noted in VAAR 811.104-71(b) and provide the required information on "equal" products, and to provide descriptive literature in accordance with FAR 52.14-21.
- E. PHOTOCELLS AND DIMMING/DAYLIGHT HARVESTING
1. Photocell shall accept 12 to 24 VAC or VDC and provide a SPDT relay for interface with remote switching system. Sensor shall interface with occupancy sensors, directly with power pack, or other system as shown.
 2. Photocell shall provide for an On/Off set-point, and a deadband to prevent the artificial light from cycling. Delay shall be incorporated into the photocell to prevent rapid response to passing clouds.
 3. Photocell set-point and deadband shall be automatically calibrated through the sensor's micro-controller by initiating the "Automatic Set-point Programming" subroutine. Further adjustment may be made manually if needed. Deadband setting shall be verified and modified

- by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).
4. Low voltage Dimming Sensors shall accept 12 to 24 VAC or VDC (from power pack or other low voltage source) and control 0 to 10 VDC dimmable ballasts by sinking up to 20 milliamps of class 2 current (typically 40 or more ballasts).
 5. Low voltage Dimming Sensor's set point shall be automatically calibrated through the sensor's micro-controller by initiating the "Automatic Set-point Programming" subroutine. Min and Max dim settings as well as set-point may be manually entered.
 6. Low voltage Dimming Sensors shall be equipped with an automatic override for 100 hour burn-in of lamps. This feature must be available at any time for lamp replacements. (Note: This function should be performed prior to any dimming of the lamps including the "auto set-point" setting.)
 7. Combination Photocell/Dimming Sensors shall accept 12 to 24 VAC or VDC (from power pack or other low voltage source) and control the On/Off function as well as the dimming function of 0 to 10 VDC dimmable ballasts.
 8. Combination Photocell/Dimming Sensor's set-point and deadband shall be automatically calibrated through the sensor's micro-controller by initiating the "Automatic Set-point Programming" subroutine. Min and Max dim settings as well as set point may be manually entered.
 9. Combination Photocell/Dimming Sensors shall be equipped with an automatic override for 100 hour burn-in of lamps. This feature must be available at any time for lamp replacements. (Note: This function should be performed prior to any dimming of the lamps including the "auto set-point" setting.)
 10. Dual zone option shall be available for Photocell, Dimming Sensors, or Combination units. The second zone shall be controlled as an "offset" from the primary zone and shall be the zone farthest from the natural light source.
 11. Standalone Ambient Light Sensors shall interface directly with the 0 to 10 VDC, without any other power source connection, and control dimmable ballasts by sinking up to 20 milliamps of class 2 current. Sensor shall incorporate a photodiode viewing out of a ceiling enclosure at a 30 degree angle from horizontal to detect diffused

light from the ambient and artificial sources. Sensor shall allow for removal of response delays for adjustment, however provide dampening delay for normal operation. Settings shall be made manually.

12. Basis-of-Design Manufacturer Products.

- a. Sensor Switch CM-PC (Photocell for On/Off)
- b. Sensor Switch CM-ADC (Dimming Sensor)
- c. Sensor Switch CM-PC-ADC (Combination Photocell/Dimming Sensor)
- d. Sensor Switch CM-PC-DZ, CM-ADC-DZ, OR CM-PC-ADC-DZ (Dual Zone Version)
- e. Sensor Switch CM-ALC (Stand Alone Ambient Light Sensor for Daylight Harvesting)
- f. Substitutions: Or equal with similar and salient characteristics. Submit in format noted in VAAR 811.104-71(b) and provide the required information on "equal" products, and to provide descriptive literature in accordance with FAR 52.14-21.

2.5 NETWORK LIGHTING CONTROLS

- A. Basis-of-Design Manufacturer: Crestron Electronics, Inc., Rockleigh, NJ 07647, Phone (800)237-2041, Fax: (201)767-1903, www.crestron.com or comparable products from a single manufacturer approved by Architect-Engineer prior to bidding.
- B. System characteristics.
 - 1. Web-accessible, network-connected programmable lighting control system that receives digital or analog signals from addressable input devices, assembles signals at central signal processor, and distributes operating signals to addressable control devices that effect a change in state.
 - a. Electronic power switching modules and relays process signals and effect circuit on-off switching, emergency switching, and 0 - 10V fluorescent dimming where indicated. Emergency switching overrides preset state and puts each circuit to the programmed emergency condition. Buttons on the module provide manual disconnect and manual circuit testing.
- C. Network lighting control panels.
 - 1. Control Panels, General: Comply with NEMA PB 1 and UL 50 (CAN/CSA C22.2, No. 94), UL 67 (CSA C22.2, No. 29), UL 489 (CAN/CSA C22.2, No. 65), and UL 916 (CSA C22.2, No. 205).
 - 2. Circuit Protected Network Lighting Control Panels: Arc-less high inrush.
 - a. Basis of Design Product: Crestron, Green Light Power Switching Network Lighting Control panel Model GLPS-HSW.

- b. Main Circuit: Main circuit breaker as indicated on the drawings.
 - c. Branch Circuit Protection: 120/208 **or** 277/480, 20 amp thermal magnetic type.
 - d. Switching Relay Types: Arc-less high inrush, lifetime rated minimum 1,000,000 on/off cycles, with air gap off protection.
 - e. Cabinet capacity as indicated on the drawings.
- D. Power switching accessories.
- 1. Switching Module, High Inrush.
 - a. Basis of Design Product: Crestron Electronic Power Switching Module Model No. GLXP-SW- series.
 - b. Channels of Switching: 10, 12, **or** 16 channel high inrush switching.
 - c. Maximum Load.
 - 1) Lighting: 16A per channel.
 - 2) Motor: 1HP at 120V **or** 2HP at 230/277V per channel.
 - 2. Switching Module, 0 - 10V Dimmable Fluorescent Ballast Load Switching Module.
 - a. Basis of Design Product: Crestron Electronic power switching module Model No. GLXP-GLXP-DIMFLV8.
 - b. Channels of Switching: 8 channel high inrush switching.
 - c. Maximum Nondimmable Load.
 - 1) Incandescent, HID, magnetic low voltage (MLV), electronic low voltage (ELV), neon/cold cathode, and fluorescent ballasts: 16A per channel.
 - 2) Motor: 1/2HP at 120V **or** 1HP at 230/277V per channel.
 - d. Maximum Dimmable Load.
 - 1) Lighting: 0 - 10V dimmable fluorescent ballasts.
 - e. Substitutions: Or equal with similar and salient characteristics. Submit in format noted in VAAR 811.104-71(b) and provide the required information on "equal" products, and to provide descriptive literature in accordance with FAR 52.14-21.
 - 3. Emergency Phase Loss Sensor: 120/277V, tripping transfer to emergency state.
 - a. Basis of Design Product: Crestron Model No. GLS-PLS-120/277.
 - b. Substitutions: Or equal with similar and salient characteristics. Submit in format noted in VAAR 811.104-71(b) and provide the required information on "equal" products, and to provide descriptive literature in accordance with FAR 52.14-21.
 - 4. Power Supply: 50W, 24 V regulated power supply with two 4-pin network connectors, fuse-protected.

- a. Basis of Design: Crestron Cresnet Power Supply Model GLA-PWS-50.
 - b. Substitutions: Or equal with similar and salient characteristics. Submit in format noted in VAAR 811.104-71(b) and provide the required information on "equal" products, and to provide descriptive literature in accordance with FAR 52.14-21.
- E. Central signal processor.
 - 1. Control Processor: Integrates sensors and other low voltage controls, devices, and subsystems through multiple control interfaces with control network. Enables addition of relays, 8 separate I/O ports in 2 isolated segments supporting up to 20 devices each, serial COM ports, DTMF interfaces, and shade controllers. MMC memory expansion card slot. 4-wire bus providing 24 VDC power to network devices, with two independent sensing inputs. Use with separate power supply.
 - a. Basis of Design: Crestron Professional Automation Mini-Control System Model PAC2M.
 - b. Mounting: Surface-mounted.
 - c. Substitutions: Or equal with similar and salient characteristics. Submit in format noted in VAAR 811.104-71(b) and provide the required information on "equal" products, and to provide descriptive literature in accordance with FAR 52.14-21.
- F. System accessories.
 - 1. Touchpanel: Controls lighting and AV settings along with other modular dimming controller functions.
 - a. 5.7 inch active-matrix color LCD touch screen 640 by 480 SVGA resolution display.
 - 1) Basis of design: Crestron Isys TPS-6L Touchpanel.
 - b. 16-bit color graphics, and dual-window HD video, HDTV, and high-resolution RGB streaming multimedia, IP intercom, and web browsing capabilities. Dynamic graphics and text capability. Enables custom control screen programming.
 - c. Video display: Scalable display on touchpanel screen.
 - d. Pushbutton Controls: 12 engraved backlit tactile pushbuttons for volume, channel, and on-screen menu navigation and programmable functions, snap-on front bezel button cover.
 - e. Mounting Kit: Wall mounting kit with power, wired Ethernet and CAT5 video connectivity, with back box and trim ring.
 - f. Powerpack: 24VDC.
 - g. Color: Ivory.

- h. Substitutions: Or equal with similar and salient characteristics. Submit in format noted in VAAR 811.104-71(b) and provide the required information on "equal" products, and to provide descriptive literature in accordance with FAR 52.14-21.
- 2. Remote Keypad Controls: Remote keypad with backlight illuminating, replaceable, engravable buttons in number indicated, with amber LED indicators, configured to fit in standard single-gang box.
 - a. Basis of Design: Crestron, Designer Series Keypad Model CNX-Series.
 - b. Faceplates: Standard manufacturer's faceplate.
 - c. Substitutions: Or equal with similar and salient characteristics. Submit in format noted in VAAR 811.104-71(b) and provide the required information on "equal" products, and to provide descriptive literature in accordance with FAR 52.14-21.
- G. Occupancy Sensor Interface Device: Integrates occupancy sensors and related sensors with control network. In separate enclosure. 4-wire bus providing 24 VDC power to network devices, with two independent sensing inputs.
 - 1. Basis of Design: Crestron Sensor Integration Module Model GLS-SIM.
 - 2. Substitutions: Or equal with similar and salient characteristics. Submit in format noted in VAAR 811.104-71(b) and provide the required information on "equal" products, and to provide descriptive literature in accordance with FAR 52.14-21.
- H. Conductors and cabling.
 - 1. Power Supply Side of Remote-Control Power Sources: Comply with requirements of Division 26 Section "Low-Voltage Electrical Power Conductors."
 - 2. UTP Cable: 100-ohm, UTP. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types.
 - a. Communications Control Cable, Non-Plenum Rated: 22 AWG data pair stranded bare copper, and 18 AWG power pair stranded bare copper, Type CM.
 - 1) Basis of Design Product: Crestron CRESNET-NP.
 - 2) Substitutions: Or equal with similar and salient characteristics. Submit in format noted in VAAR 811.104-71(b) and provide the required information on "equal" products, and to provide descriptive literature in accordance with FAR 52.14-21.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Installation shall be in accordance with the NEC, manufacturer's instructions and as shown on the drawings or specified.
- B. Aim outdoor photocell switch according to manufacturer's recommendations. Set adjustable window slide for 1 footcandle photocell turn-on.
- C. Aiming for wall-mounted and ceiling-mounted motion sensor switches shall be per manufacturer's recommendations.
- D. Set occupancy sensor "on" duration to 15 minutes.
- E. Locate light level sensors as indicated and in accordance with the manufacturer's recommendations. Adjust sensor for the scheduled light level at the typical work plane for that area.
- F. Label time switches and contactors with a unique designation.
- G. Network lighting controls.
 - 1. Do not install network power controls until space is enclosed, HVAC systems are running, and overhead and wet work in space are complete.
 - 2. Install network power switching controls in accordance with manufacturer's instructions.
 - 3. Provide panelboard schedule in pocket provided in panel doors.
 - 4. Install and program software to meet the Owner's requirements. Provide current licenses. And backup copies of the software for the Owner's records.
 - 5. Provide manufacturer's system startup and adjustment.
 - 5. Switch each load on and off with manual line test feature of the power switching module before installing processors
 - 6. Perform operational testing to verify compliance with Specifications. Adjust as required.
 - 7. Within 12 months of the date of Substantial Completion provide onsite service to adjust the system to account for actual occupied conditions.

3.2 ACCEPTANCE CHECKS AND TESTS

- A. Perform in accordance with the manufacturer's recommendations.
- B. Upon completion of installation, conduct an operating test to show that equipment operates in accordance with requirements of this section.
- C. Test for full range of dimming ballast and dimming controls capability. Observe for visually detectable flicker over full dimming range.
- D. Test occupancy sensors for proper operation. Observe for light control over entire area being covered.

3.3 FOLLOW-UP VERIFICATION

- A. Upon completion of acceptance checks and tests, the Contractor shall show by demonstration in service that the lighting control devices are in good operating condition and properly performing the intended function.
- B. Network lighting controls.
 - 1. Factory authorized service representative to instruct owner's staff to adjust, operate and maintain network power switching systems; and provide instruction using the system software.
 - 2. Training: Train Owner's personnel to operate, maintain, and program network power switching systems. Allow for a minimum of trips to the jobsite to provide additional training as needed.

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**SECTION 26 24 16
PANELBOARDS**

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies the furnishing, installation, and connection of panelboards.

1.2 RELATED WORK

- A. Section 09 91 00, PAINTING: Identification and painting of panelboards.
- B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one Section of Division 26.
- C. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Cables and wiring.
- D. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.
- E. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits and outlet boxes.
- F. Section 26 43 13, TRANSIENT-VOLTAGE SURGE SUPPRESSION: Surge suppressors installed in panelboards.

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. Shop Drawings:
 - 1. Sufficient information shall be clearly presented to determine compliance with drawings and specifications.
 - 2. Include electrical ratings, dimensions, mounting details, materials, wiring diagrams, accessories, and weights of equipment. Complete nameplate data, including manufacturer's name and catalog number.
- C. Manuals:
 - 1. When submitting the shop drawings, submit companion copies of complete maintenance and operating manuals, including technical data sheets and wiring diagrams.

2. If changes have been made to the maintenance and operating manuals that were originally submitted, then submit four copies of updated maintenance and operating manuals to the COR two weeks prior to final inspection.
- D. Certification: Two weeks prior to final inspection, submit four copies of the following to the COR:
 1. Certification by the manufacturer that the materials conform to the requirements of the drawings and specifications.
 2. Certification by the contractor that the materials have been properly installed, connected, and tested.

1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. National Electrical Manufacturers Association (NEMA):
 - PB-1-06.....Panelboards
 - 250-08.....Enclosures for Electrical Equipment (1000V Maximum)
- C. National Fire Protection Association (NFPA):
 - 70-2011National Electrical Code (NEC)
 - 70E-2004.....Standard for Electrical Life Safety in the Workplace
- D. Underwriters Laboratories, Inc. (UL):
 - 50-95.....Enclosures for Electrical Equipment
 - 67-09.....Panelboards
 - 489-09.....Molded Case Circuit Breakers and Circuit Breaker Enclosures

PART 2 - PRODUCTS

2.1 PANELBOARDS

- A. Panelboards shall be in accordance with UL, NEMA, NEC, and as shown on the drawings.
- B. Panelboards shall be standard manufactured products.
- C. All panelboards shall be hinged "door in door" type with:
 1. Interior hinged door with hand-operated latch or latches, as required to provide access only to circuit breaker operating handles, not to energized parts.

2. Outer hinged door shall be securely mounted to the panelboard box with factory bolts, screws, clips, or other fasteners, requiring a tool for entry. Hand-operated latches are not acceptable.
3. Push inner and outer doors shall open left to right.
- D. All panelboards shall be completely factory-assembled with molded case circuit breakers and integral accessories, such as surge protective devices per Section 26 43 13, TRANSIENT-VOLTAGE SURGE SUPPRESSION, as scheduled on the drawings or specified herein. Include one-piece removable, inner dead front cover, independent of the panelboard cover.
- E. Panelboards shall have main breaker or main lugs, bus size, voltage, phase, top or bottom feed, and flush or surface mounting as scheduled on the drawings.
- F. Panelboards shall conform to NEMA PB-1, NEMA AB-1, and UL 67 and have the following features:
 1. Non-reduced size copper bus bars with current ratings as shown on the panel schedules, rigidly supported on molded insulators.
 2. Bus bar connections to the branch circuit breakers shall be the "distributed phase" or "phase sequence" type.
 3. Mechanical lugs furnished with panelboards shall be cast, stamped, or machined metal alloys of sizes suitable for the conductors to which they will be connected.
 4. Neutral bus shall be 100% or 200% rated as indicated on the drawings, mounted on insulated supports.
 5. Grounding bus bar shall be equipped with screws or lugs for the connection of grounding wires.
 6. Buses shall be braced for the available short-circuit current. Bracing shall not be less than 10,000 A symmetrical for 120/208 V and 120/240 V panelboards, and 14,000 A symmetrical for 277/480 V panelboards.
 7. Branch circuit panelboards shall have buses fabricated for bolt-on type circuit breakers.
 8. Protective devices shall be designed so that they can easily be replaced.
 9. Where designated on panel schedule "spaces," include all necessary bussing, device support, and connections. Provide blank cover for each space.

10. In two section panelboards, the main bus in each section shall be full size. The first section shall be furnished with subfeed lugs on the line side of main lugs only, or through-feed lugs for main breaker type panelboards, and have cable connections to the second section. Panelboard sections with tapped bus or crossover bus are not acceptable.
11. Series-rated panelboards are not permitted.

2.2 CABINETS AND TRIMS

A. Cabinets:

1. Provide galvanized steel cabinets to house panelboards. Cabinets for outdoor panelboards shall be factory primed and suitably treated with a corrosion-resisting paint finish meeting UL 50 and UL 67.
2. Cabinet enclosure shall not have ventilating openings.
3. Cabinets for panelboards may be of one-piece formed steel or of formed sheet steel with end and side panels welded, riveted, or bolted as required.

2.3 MOLDED CASE CIRCUIT BREAKERS FOR PANELBOARDS

- A. Circuit breakers shall be per UL 489, in accordance with the NEC, as shown on the drawings, and as specified.
- B. Circuit breakers in panelboards shall be bolt-on type.
- C. Molded case circuit breakers shall have minimum interrupting rating as required to withstand the available fault current, but not less than:
 1. 120/208 V Panelboard: 10,000 A symmetrical.
 2. 120/240 V Panelboard: 10,000 A symmetrical.
 3. 277/480 V Panelboard: 14,000 A symmetrical.
- D. Molded case circuit breakers shall have automatic, trip free, non-adjustable, inverse time, and instantaneous magnetic trips for 100 A frame or lower. Magnetic trip shall be adjustable from 3x to 10x for breakers with 600 A frames and higher. Breaker trip setting shall be set in the field, based on the approved protective device study as specified in Section 26 05 71, ELECTRICAL SYSTEM PROTECTIVE DEVICE STUDY. Factory setting shall be HI, unless otherwise noted.
- E. Breaker features shall be as follows:
 1. A rugged, integral housing of molded insulating material.
 2. Silver alloy contacts.
 3. Arc quenchers and phase barriers for each pole.
 4. Quick-make, quick-break, operating mechanisms.

5. A trip element for each pole, thermal magnetic type with long time delay and instantaneous characteristics, a common trip bar for all poles and a single operator.
6. Electrically and mechanically trip free.
7. An operating handle which indicates ON, TRIPPED, and OFF positions.
8. An overload on one pole of a multipole breaker shall automatically cause all the poles of the breaker to open.
9. Ground fault current interrupting breakers, shunt trip breakers, lighting control breakers (including accessories to switch line currents), or other accessory devices or functions shall be provided where indicated.
10. For circuit breakers being added to existing panelboards, coordinate the breaker type with existing panelboards. Modify the panel directory accordingly.

2.4 SURGE SUPPRESSION

Where shown on drawings, furnish panelboard with integral transient voltage surge suppression device. Refer to Section 26 43 13, TRANSIENT-VOLTAGE SURGE SUPPRESSION.

2.5 SEPARATELY ENCLOSED MOLDED CASE CIRCUIT BREAKERS

- A. Where separately enclosed molded case circuit breakers are shown on the drawings, provide circuit breakers in accordance with the applicable requirements of those specified for panelboards.
- B. Enclosures are to be of the NEMA types shown on the drawings. Where the types are not shown, they are to be the NEMA type most suitable for the environmental conditions where the circuit breakers are being installed.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be in accordance with the manufacturer's instructions, the NEC, as shown on the drawings, and as specified.
- B. Locate panelboards so that the present and future conduits can be conveniently connected.
- C. Install a printed schedule of circuits in each panelboard after approval by the COR. Schedules shall be printed on the panelboard directory cards, installed in the appropriate panelboards, and incorporate all applicable contract changes. Information shall indicate outlets, lights, devices, or other equipment controlled by each circuit, and the final room numbers served by each circuit.

- D. Mount the fully-aligned panelboard such that the maximum height of the top circuit breaker above the finished floor shall not exceed 78 in [1980 mm]. Mount panelboards that are too high such that the bottom of the cabinets will not be less than 6 in [150 mm] above the finished floor.
- E. For panelboards located in areas accessible to the public, paint the exposed surfaces of the trims, doors, and boxes with finishes to match surrounding surfaces after the panelboards have been installed.
- F. Rust and scale shall be removed from the inside of existing backboxes where new panelboards are to be installed. Paint inside of backboxes with rust-preventive paint before the new panelboard interior is installed. Provide new trim and doors for these panelboards. Covers shall fit tight to the box with no gaps between the cover and the box.

3.2 ACCEPTANCE CHECKS AND TESTS

- A. Perform in accordance with the manufacturer's recommendations. Include the following visual and mechanical inspections and electrical tests:
 - 1. Visual and Mechanical Inspection
 - a. Compare equipment nameplate data with specifications and approved shop drawings.
 - b. Inspect physical, electrical, and mechanical condition.
 - c. Verify appropriate anchorage and required area clearances.
 - d. Verify that circuit breaker sizes and types correspond to approved shop drawings.
 - e. To verify tightness of accessible bolted electrical connections, use the calibrated torque-wrench method or perform thermographic survey after energization.
 - f. Clean panelboard.

3.3 FOLLOW-UP VERIFICATION

Upon completion of acceptance checks, settings, and tests, the contractor shall demonstrate that the panelboards are in good operating condition and properly performing the intended function.

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SECTION 26 27 26
WIRING DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies the furnishing, installation and connection of wiring devices.

1.2 RELATED WORK

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements that are common to more than one section of Division 26.
- B. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits and outlets boxes.
- C. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Cables and wiring.
- D. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path to ground for possible ground fault currents.

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:
- B. Shop Drawings:
 - 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
 - 2. Include electrical ratings, dimensions, mounting details, construction materials, grade and termination information.
- C. Manuals: Two weeks prior to final inspection, deliver four copies of the following to the COR: Technical data sheets and information for ordering replacement units.
- D. Certifications: Two weeks prior to final inspection, submit four copies of the following to the COR: Certification by the Contractor that the devices comply with the drawings and specifications, and have been properly installed, aligned, and tested.

1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by basic designation only.
- B. National Fire Protection Association (NFPA):
70-11.....National Electrical Code (NEC)
- C. National Electrical Manufacturers Association (NEMA):
WD 1.....General Color Requirements for Wiring Devices
WD 6Wiring Devices - Dimensional Requirements
- D. Underwriter's Laboratories, Inc. (UL):
5.....Surface Metal Raceways and Fittings
20.....General-Use Snap Switches
231.....Power Outlets
467.....Grounding and Bonding Equipment
498.....Attachment Plugs and Receptacles
943.....Ground-Fault Circuit-Interrupters

PART 2 - PRODUCTS

2.1 RECEPTACLES

- A. General: All receptacles shall be listed by Underwriters Laboratories, Inc., and conform to NEMA WD 6.
 - 1. Mounting straps shall be plated steel, with break-off plaster ears and shall include a self-grounding feature. Terminal screws shall be brass, brass plated or a copper alloy metal.
 - 2. Receptacles shall have provisions for back wiring with separate metal clamp type terminals (four min.) and side wiring from four captively held binding screws.
- B. Duplex Receptacles: Extra heavy duty, hospital-grade, single phase, 20 ampere, 120 volts, 2-pole, 3-wire, and conform to the NEMA 5-20R configuration in NEMA WD 6. The duplex type shall have break-off feature for two-circuit operation. The ungrounded pole of each receptacle shall be provided with a separate terminal.
 - 1. Bodies shall be ivory in color.
 - 2. Ground Fault Interrupter Duplex Receptacles: Shall be an integral unit, extra-heavy-duty, hospital-grade, suitable for mounting in a standard outlet box.

- a. Ground fault interrupter shall consist of a differential current transformer, solid state sensing circuitry and a circuit interrupter switch. Device shall have nominal sensitivity to ground leakage current of five milliamperes and shall function to interrupt the current supply for any value of ground leakage current above five milliamperes (+ or - 1 milliamp) on the load side of the device. Device shall have a minimum nominal tripping time of 1/30th of a second.
- 3. Safety Type Duplex Receptacles, Hospital-grade:
 - a. Bodies shall be gray in color.
 - 1) Shall permit current to flow only while a standard plug is in the proper position in the receptacle.
 - 2) Screws exposed while the wall plates are in place shall be the tamperproof type.
- C. Locking Receptacles:
 - 1. Heavy-duty, single phase, 20 ampere, 120 volts, 2-pole, 3-wire, and conform to the NEMA L5-20R configuration in NEMA WD 6. The duplex type shall have break-off feature for two-circuit operation. The ungrounded pole of each receptacle shall be provided with a separate terminal.
 - 2. Heavy-duty, single phase, 30 ampere, 125/250 volts, 3-pole, 4-wire, and conform to the NEMA L14-30R configuration in NEMA WD 6. The duplex type shall have break-off feature for two-circuit operation. The ungrounded pole of each receptacle shall be provided with a separate terminal.
 - 3. Heavy-duty, three phase, 50 ampere, 250 volts, 3-pole, 4-wire, and conform to the NEMA L15-50R configuration in NEMA WD 6. The duplex type shall have break-off feature for two-circuit operation. The ungrounded pole of each receptacle shall be provided with a separate terminal.
 - 4. Bodies shall be ivory in color.

2.2 TOGGLE SWITCHES

- A. Toggle Switches: Shall be totally enclosed tumbler type with bodies of phenolic compound. Toggle handles shall be ivory in color unless otherwise specified. The rocker type switch is not acceptable and will not be approved.

1. Shall be single unit toggle, butt contact, quiet AC type, heavy-duty general-purpose use with an integral self grounding mounting strap with break-off plaster ears and provisions for back wiring with separate metal wiring clamps and side wiring with captively held binding screws.
2. Ratings:
 - a. 120 volt circuits: 20 amperes at 120-277 volts AC.
 - b. 277 volt circuits: 20 amperes at 120-277 volts AC.

2.3 MANUAL DIMMING CONTROL

- A. Slide dimmer with on/off control, single-pole or three-way as shown on plans. Faceplates shall be ivory in color unless otherwise specified.
- B. Manual dimming controls shall be fully compatible with electronic dimming ballasts and approved by the ballast manufacturer, shall operate over full specified dimming range, and shall not degrade the performance or rated life of the electronic dimming ballast and lamp.

2.4 WALL PLATES

- A. Wall plates for switches and receptacles shall be Type 302 stainless steel. Oversize plates are not acceptable.
- B. Color shall be ivory unless otherwise specified.
- C. Standard NEMA design, so that products of different manufacturers will be interchangeable. Dimensions for openings in wall plates shall be accordance with NEMA WD 6.
- D. For receptacles or switches mounted adjacent to each other, wall plates shall be common for each group of receptacles or switches.
- E. Wall plates for data, telephone or other communication outlets shall be as specified in the associated specification.

2.5 SURFACE MULTIPLE-OUTLET ASSEMBLIES

- A. Assemblies shall conform to the requirements of NFPA 70-2011 and UL 5.
- B. Shall have the following features:
 1. Enclosures:
 - a. Thickness of steel shall be not less than 0.040 inch [1 mm] steel for base and cover. Nominal dimension shall be 1-1/2 by 2-3/4 inches [40 by 70 mm] with inside cross sectional area not less than 3.5 square inches [2250 square mm]. The enclosures shall be thoroughly cleaned, phosphatized and painted at the factory with primer and the manufacturer's standard baked enamel or lacquer finish.

2. Receptacles shall be duplex, hospital grade. See paragraph 'RECEPTACLES' in this section. Device cover plates shall be the manufacturer's standard corrosion resistant finish and shall not exceed the dimensions of the enclosure.
3. Unless otherwise shown on drawings, spacing of the receptacles along the strip shall be 24 inches [600mm] on centers.
4. Wires within the assemblies shall be not less than No. 12 AWG copper, with 600 volt ratings.
5. Installation fittings shall be designed for the strips being installed including bends, offsets, device brackets, inside couplings, wire clips, and elbows.
6. Bond the strips to the conduit systems for their branch supply circuits.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be in accordance with the NEC and as shown as on the drawings.
- B. Ground terminal of each receptacle shall be bonded to the outlet box with an approved green bonding jumper, and also connected to the green equipment grounding conductor.
- C. Outlet boxes for light and dimmer switches shall be mounted on the strike side of doors.
- D. Coordinate with other work, including painting, electrical boxes and wiring installations, as necessary to interface installation of wiring devices with other work. Coordinate the electrical work with the work of other trades to ensure that wiring device flush outlets are positioned with box openings aligned with the face of the surrounding finish material. Pay special attention to installations in cabinet work, and in connection with laboratory equipment.
- E. Exact field locations of floors, walls, partitions, doors, windows, and equipment may vary from locations shown on the drawings. Prior to locating sleeves, boxes and chases for roughing-in of conduit and equipment, the Contractor shall coordinate exact field location of the above items with other trades. In addition, check for exact direction of door swings so that local switches are properly located on the strike side.
- F. Install wall switches 48 inches [1200mm] above floor, OFF position down.
- G. Install wall dimmers 48 inches [1200mm] above floor; derate ganged dimmers as instructed by manufacturer; do not use common neutral.

- H. Install convenience receptacles 18 inches [450mm] above floor, and 6 inches [152mm] above counter backsplash or workbenches. Install specific-use receptacles at heights shown on the drawings.
- I. Label device plates with a permanent adhesive label listing panel and circuit feeding the wiring device.
- J. Test wiring devices for damaged conductors, high circuit resistance, poor connections, inadequate fault current path, defective devices, or similar problems using a portable receptacle tester. Correct circuit conditions, remove malfunctioning units and replace with new, and retest as specified above.
- K. Test GFCI devices for tripping values specified in UL 1436 and UL 943.

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SECTION 26 29 11
MOTOR STARTERS

PART 1 - GENERAL

1.1 DESCRIPTION

All motor starters and variable speed motor controllers, including installation and connection (whether furnished with the equipment specified in other Divisions or otherwise), shall meet these specifications.

1.2 RELATED WORK

- A. Other sections which specify motor driven equipment, except elevator motor controllers.
- B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one Section of Division 26.
- C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS:
- B. Shop Drawings:
 - 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
 - 2. Include electrical ratings, dimensions, weights, mounting details, materials, running over current protection, size of enclosure, over current protection, wiring diagrams, starting characteristics, interlocking and accessories.
- C. Manuals:
 - 1. Submit, simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals, including technical data sheets, wiring diagrams and information for ordering replacement parts.
 - a. Wiring diagrams shall have their terminals identified to facilitate installation, maintenance and operation.
 - b. Wiring diagrams shall indicate internal wiring for each item of equipment and interconnections between the items of equipment.

- c. Elementary schematic diagrams shall be provided for clarity of operation.
- 2. Two weeks prior to the project final inspection, submit four copies of the final updated maintenance and operating manual to the COR.
- D. Certification: Two weeks prior to final inspection, unless otherwise noted, submit four copies of the following certifications to the COR:
 - 1. Certification that the equipment has been properly installed, adjusted, and tested.
 - 2. Certification by the manufacturer that medium voltage motor controller(s) conforms to the requirements of the drawings and specifications. This certification must be furnished to the COR prior to shipping the controller(s) to the job site.

1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by basic designation only.
- B. Institute of Electrical and Electronic Engineers (IEEE):
 - 519.....Recommended Practices and Requirements for
Harmonic Control in Electrical Power Systems
 - C37.90.1.....Standard Surge Withstand Capability (SWC) Tests
for Protective Relays and Relay Systems
- C. National Electrical Manufacturers Association (NEMA):
 - ICS 1.....Industrial Control and Systems General
Requirements
 - ICS 1.1.....Safety Guidelines for the Application,
Installation and Maintenance of Solid State
Control
 - ICS 2.....Industrial Control and Systems, Controllers,
Contactors and Overload Relays Rated 600 Volts
DC
 - ICS 6.....Industrial Control and Systems Enclosures
 - ICS 7.....Industrial Control and Systems Adjustable-Speed
Drives
 - ICS 7.1.....Safety Standards for Construction and Guide for
Selection, Installation and Operation of
Adjustable-Speed Drive Systems
- D. National Fire Protection Association (NFPA):
 - 70-11.....National Electrical Code (NEC)

E. Underwriters Laboratories Inc. (UL):

508.....Industrial Control Equipment

PART 2 - PRODUCTS

2.1 MOTOR STARTERS, GENERAL

- A. Shall be in accordance with the requirements of the IEEE, NEC, NEMA (ICS 1, ICS 1.1, ICS 2, ICS 6, ICS 7 and ICS 7.1) and UL.
- B. Shall have the following features:
 - 1. Separately enclosed unless part of another assembly.
 - 2. Circuit breakers and safety switches within the motor controller enclosures shall have external operating handles with lock-open padlocking provisions and shall indicate the ON and OFF positions.
 - 3. Motor control circuits:
 - a. Shall operate at not more than 120 volts.
 - b. Shall be grounded except as follows:
 - 1) Where isolated control circuits are shown.
 - 2) Where manufacturers of equipment assemblies recommend that the control circuits be isolated.
 - c. Incorporate a separate, heavy duty, control transformer within each motor controller enclosure to provide the control voltage for each motor operating over 120 volts.
 - d. Incorporate over current protection for both primary and secondary windings of the control power transformers in accordance with the NEC.
 - 4. Overload current protective devices:
 - a. Overload relay (solid state type).
 - b. One for each pole.
 - c. Manual reset on the door of each motor controller enclosure.
 - d. Correctly sized for the associated motor's rated full load current.
 - e. Check every motor controller after installation and verify that correct sizes of protective devices have been installed.
 - f. Deliver four copies of a summarized list to the COR, which indicates and adequately identifies every motor controller installed. Include the catalog numbers for the correct sizes of protective devices for the motor controllers.
 - 5. Hand-Off-Automatic (H-O-A) switch is required unless specifically stated on the drawings as not required for a particular starter. H-O-A switch is not required for manual motor starters.

6. Incorporate into each control circuit a 120-volt, solid state time delay relay (ON delay), minimum adjustable range from 0.3 to 10 minutes, with transient protection. Time delay relay is not required where H-O-A switch is not required.
7. Unless noted otherwise, equip with not less than two normally open and two normally closed auxiliary contacts. Provide green run pilot lights and H-O-A control devices as indicated, operable at front of enclosure without opening enclosure. Push buttons, selector switches, pilot lights, etc., shall be interchangeable.
8. Enclosures:
 - a. Shall be the NEMA types shown on the drawings for the motor controllers and shall be the NEMA types which are the most suitable for the environmental conditions where the motor controllers are being installed.
 - b. Doors mechanically interlocked to prevent opening unless the breaker or switch within the enclosure is open. Provision for padlock must be provided.
 - c. Enclosures shall be primed and finish coated at the factory with the manufacturer's prime coat and standard finish.
- C. Motor controllers incorporated with equipment assemblies shall also be designed for the specific requirements of the assemblies.
- D. For motor controllers being installed in existing motor control centers or panelboards, coordinate with the existing centers or panelboards.
- E. Additional requirements for specific motor controllers, as indicated in other sections, shall also apply.
- F. Provide a disconnecting means or safety switch near and within sight of each motor. Provide all wiring and conduit required to facilitate a complete installation.

2.2 MANUAL MOTOR STARTERS

- A. Shall be in accordance with applicable requirements of 2.1 above.
- B. Manual motor starters.
 1. Starters shall be general-purpose Class A, manually operated type with full voltage controller for induction motors, rated in horsepower.
 2. Units shall include overload and low voltage protection, red pilot light, NO and NC auxiliary contacts, and toggle operator.
- C. Fractional horsepower manual motor starters.
 1. Starters shall be general-purpose Class A, manually operated with full voltage controller for fractional horsepower induction motors.

2. Units shall include thermal overload protection, red pilot light and toggle operator.

D. Motor starting switches.

1. Switches shall be general-purpose Class A, manually operated type with full voltage controller for fractional horsepower induction motors.

2. Units shall include thermal overload protection, red pilot light, low voltage protection, NO and NC auxiliary contacts, and toggle operator.

2.3 MAGNETIC MOTOR STARTERS

A. Shall be in accordance with applicable requirements of 2.1 above.

B. Starters shall be general-purpose, Class A magnetic controllers for induction motors rated in horsepower. Minimum size 0.

C. Where combination motor starters are used, combine starter with protective or disconnect device in a common enclosure.

D. Provide phase loss protection for each starter, with contacts to de-energize the starter upon loss of any phase.

E. Unless otherwise indicated, provide full voltage non-reversing across-the-line mechanisms for motors less than 75 HP, closed by coil action and opened by gravity. For motors 75 HP and larger, provide reduced voltage starters. Equip starters with 120V AC coils and individual control transformer unless otherwise noted. Locate "reset" button to be accessible without opening the enclosure.

2.4 VARIABLE SPEED MOTOR CONTROLLERS

A. Shall be in accordance with applicable portions of 2.1 above.

B. Shall be solid state, micro processor-based with adjustable frequency and voltage, three phase output capable of driving standard NEMA B design, three phase alternating current induction motors at full rated speed. The drives shall utilize a full wave bridge design incorporating diode rectifier circuitry with pulse width modulation (PWM). Other control techniques are not acceptable. Silicon controlled rectifiers (SCR) shall not be used in the rectifying circuitry. The drives shall be designed to be used on variable torque loads and shall be capable of providing sufficient torque to allow the motor to break away from rest upon first application of power.

C. Unit shall be capable of operating within voltage parameters of plus 10 to minus 10 percent of line voltage, and be suitably rated for the full load amps of the maximum watts (HP) within its class.

D. Operating and Design Conditions:

Elevation: 100% load capacity (no derating) up to 3280 ft. (1000m); 1% derating for each 328 ft. (100m) above 3280 ft. (1000m); max. 9842 ft. (3000m) AMSL

Temperatures: Maximum +90°F Minimum -10°F

Relative Humidity: 95%

Drive Location: Mechanical Prefabricated Penthouse Unit Building

E. Controllers shall have the following features:

1. Isolated power for control circuits.
2. Manually re-settable motor overload protection for each phase.
3. Adjustable current limiting circuitry to provide soft motor starting. Maximum starting current shall not exceed 200 percent of motor full load current.
4. Independent acceleration and deceleration time adjustment, manually adjustable from 2 to 30 seconds. (Set timers to the equipment manufacturer's recommended time in the above range.)
5. Provide 4 to 20 ma current follower circuitry for interface with mechanical sensor devices.
6. Automatic frequency adjustment from 20 Hz to 60 Hz.
7. Provide circuitry to initiate an orderly shutdown when any of the conditions listed below occur. The controller shall not be damaged by any of these electrical disturbances and shall automatically restart when the conditions are corrected. The drive shall be able to restart into a rotating motor operating in either the forward or reverse direction and matching that frequency.
 - a. Incorrect phase sequence.
 - b. Single phasing.
 - c. Over voltage in excess of 10 percent.
 - d. Under voltage in excess of 10 percent.
 - e. Running over current above 110 percent (shall not automatically reset for this condition.)
 - f. Instantaneous overcurrent above 150 percent (shall not automatically reset for this condition).
 - g. Surge voltage in excess of 1000 volts.
 - h. Short duration power outages of 12 cycles or less (i.e., distribution line switching, generator testing, and automatic transfer switch operations.)
8. Provide automatic shutdown on receipt of a power transfer warning signal from an automatic transfer switch. Controller shall automatically restart motor after the power transfer.

9. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.
 10. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.
 11. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.
- F. Minimum efficiency shall be 95 percent at 100 percent speed and 85 percent at 50 percent speed.
- G. The displacement power factor of the controller shall not be less than 95 percent under any speed or load condition.
- H. Controllers shall include a door interlocked fused safety disconnect switch or door interlocked circuit breaker switch which will disconnect all input power.
- I. Controller shall include a 3% line reactor, and RFI/EMI filter.
- J. The following accessories are to be door mounted:
1. AC Power on light.
 2. Ammeter (RMS motor current).
 3. HAND-OFF-AUTOMATIC switch.
 4. Manual speed control in HAND mode.
 5. System protection lights indicating that the system has shutdown and will not automatically restart.
 6. System protection light indicating that the system has shutdown but will restart when conditions return to normal.
 7. Manual variable speed controller by-pass switch.
 8. Diagnostic shutdown indicator lights for each shutdown condition.
 9. Provide two N.O. and two N.C. dry contacts rated 120 volts, 10 amperes, 60 HZ for remote indication of the following:
 - a. System shutdown with auto restart.
 - b. System shutdown without auto restart.
 - c. System running.
 10. Incorporate into each control circuit a 120-volt, time delay relay (ON delay), adjustable from 0.3-10 minutes, with transient protection. Provide transformer/s for the control circuit/s.

11. Controller shall not add any current or voltage transients to the input AC power distribution system nor shall transients from other devices on the AC power distribution system affect the controller. Controllers shall be protected to comply with IEEE C37.90.1 and UL-508. Line noise and harmonic voltage distortion shall not exceed the values allowed by IEEE 519.
- K. Hardware and software to enable the BAS to monitor, control, and display controller status and alarms.
- L. Network Communications Ports: Ethernet and RS-422/485.
- M. Embedded BAS Protocols for Network Communications: As specified in Division 22.
- N. Bypass Operation: Manually transfers motor between power converter output and bypass circuit, manually, automatically, or both. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter. Transfer between power converter and bypass contactor and retransfer shall only be allowed with the motor at zero speed.
- O. Bypass Controller: Provide contactor-style bypass, arranged to isolate the power converter input and output and permit safe testing of the power converter, both energized and de-energized, while motor is operating in bypass mode. Motor overload protection shall be provided.
 1. Bypass Contactor: Load-break NEMA-rated contactor.
 2. Input and Output Isolating Contactors: Non-load-break, NEMA-rated contactors.
 3. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

2.5 MOTOR CONTROL STATIONS

- A. Shall have the following features:
 1. Designed for suitably fulfilling the specific control functions for which each station is being installed.
 2. Coordinate the use of momentary contacts and maintained contacts with the complete motor control systems to insure safety for people and equipment.
 3. Each station shall have two pilot lights behind red and green jewels and a circuit to its motor controller. Connect the lamps so they will be energized as follows:
 - a. Red while the motor is running.
 - b. Green while the motor is stopped.

4. Where two or more stations are mounted adjacent to each other, install a common wall plate, except where the designs of the stations make such common plates impracticable.
 5. Identify each station with a permanently attached individual nameplate, of laminated black phenolic resin with a white core and engraved lettering not less than 6 mm (1/4-inch) high. Identify the motor by its number or other designation and indicate the function fulfilled by the motor.
- B. Components of Motor Control Circuits:
1. Shall also be designed and arranged so that accidental faulting or grounding of the control conductors will not be able to start the motors.
 2. Use of locking type STOP pushbuttons or switches, which cause motors to restart automatically when the pushbuttons or switches are released, will not be permitted.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install motor control equipment in accordance with manufacturer's recommendations, the NEC, NEMA and as shown on the drawings.
- B. Furnish and install heater elements in motor starters and to match the installed motor characteristics. Submit a list of all motors listing motor nameplate rating and heater element installed.
- C. Motor Data: Provide neatly-typed label inside each motor starter enclosure door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, voltage/phase rating and heater element installed.
- D. Connect hand-off auto selector switches so that automatic control only is by-passed in "manual" position and any safety controls are not by-passed.
- E. Install manual motor starters in flush enclosures in finished areas.
- F. Examine control diagrams indicated before ordering motor controllers. Should conflicting data exist in specifications, drawings and diagrams, request corrected data prior to placing orders.

3.2 ADJUSTING

- A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
- B. Adjust overload-relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.

- C. Adjust trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust at six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify COR before increasing settings.
- D. Set the taps on reduced-voltage autotransformer controllers at 65 percent.
- E. In reduced-voltage solid-state controllers, set field-adjustable switches and program microprocessors for required start and stop sequences.

3.3 ACCEPTANCE CHECKS AND TESTS

- A. Perform in accordance with the manufacturer's recommendations. Include the following visual and mechanical inspections and electrical tests:
 - 1. Visual and Mechanical Inspection
 - a. Compare equipment nameplate data with specifications and approved shop drawings.
 - b. Inspect physical, electrical, and mechanical condition.
 - c. Inspect contactors.
 - d. Clean motor starters and variable speed motor controllers.
 - e. Verify overload element ratings are correct for their applications.
 - f. If motor-running protection is provided by fuses, verify correct fuse rating.
 - g. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
 - 2. Variable speed motor controllers:
 - a. Final programming and connections to variable speed motor controllers shall be by a factory-trained technician. Set all programmable functions of the variable speed motor controllers to meet the requirements and conditions of use.
 - b. Test all control and safety features of the variable frequency drive.

3.4 FOLLOW-UP VERIFICATION

Upon completion of acceptance checks, settings, and tests, the Contractor shall show by demonstration in service that the motor starters and variable speed motor controllers are in good operating condition and properly performing the intended functions.

3.5 SPARE PARTS

Two weeks prior to the final inspection, provide one complete set of spare fuses (including heater elements) for each starter/controller installed on this project.

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SECTION 26 29 21
DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies the furnishing, installation, and connection of low voltage disconnect switches.

1.2 RELATED WORK

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.
- B. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES 600 VOLTS AND BELOW: Cables and wiring.
- C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground faults.
- D. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits for cables and wiring.
- E. Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS: Motor rated toggle switches.

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. Shop Drawings:
 - 1. Clearly present sufficient information to determine compliance with drawings and specifications.
 - 2. Include electrical ratings, dimensions, mounting details, materials, enclosure types, and fuse types and classes.
 - 3. Show the specific switch and fuse proposed for each specific piece of equipment or circuit.
- C. Manuals:
 - 1. Provide complete maintenance and operating manuals for disconnect switches, including technical data sheets, wiring diagrams, and information for ordering replacement parts. Deliver four copies to the COR two weeks prior to final inspection.
 - 2. Terminals on wiring diagrams shall be identified to facilitate maintenance and operation.

3. Wiring diagrams shall indicate internal wiring and any interlocking.
- D. Certifications: Two weeks prior to the final inspection, submit four copies of the following certifications to the COR:
 1. Certification by the manufacturer that the materials conform to the requirements of the drawings and specifications.
 2. Certification by the contractor that the materials have been properly installed, connected, and tested.

1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. National Electrical Manufacturers Association (NEMA):
 - FU 1-07.....Low Voltage Cartridge Fuses
 - KS 1-06.....Enclosed and Miscellaneous Distribution
Equipment Switches (600 Volts Maximum)
- C. National Fire Protection Association (NFPA):
 - 70-11.....National Electrical Code (NEC)
- D. Underwriters Laboratories, Inc. (UL):
 - 98-04.....Enclosed and Dead-Front Switches
 - 248-00.....Low Voltage Fuses
 - 977-94.....Fused Power-Circuit Devices

PART 2 - PRODUCTS

2.1 LOW VOLTAGE FUSIBLE SWITCHES RATED 600 AMPERES AND LESS

- A. In accordance with UL 98, NEMA KS1, and NEC.
- B. Shall have NEMA classification General Duty (GD) for 240 V switches and NEMA classification Heavy Duty (HD) for 480 V switches.
- C. Shall be HP rated.
- D. Shall have the following features:
 1. Switch mechanism shall be the quick-make, quick-break type.
 2. Copper blades, visible in the OFF position.
 3. An arc chute for each pole.
 4. External operating handle shall indicate ON and OFF position and have lock-open padlocking provisions.
 5. Mechanical interlock shall permit opening of the door only when the switch is in the OFF position, defeatable to permit inspection.
 6. Fuse holders for the sizes and types of fuses specified.
 7. Solid neutral for each switch being installed in a circuit which includes a neutral conductor.
 8. Ground lugs for each ground conductor.
 9. Enclosures:

- a. Shall be the NEMA types shown on the drawings for the switches.
- b. Where the types of switch enclosures are not shown, they shall be the NEMA types most suitable for the ambient environmental conditions.
 - 1) Unless otherwise indicated on the plans, all outdoor switches shall be NEMA 3R.
 - 2) Unless otherwise indicated on the plans, all indoor switches located in kitchen areas shall be NEMA 4.
 - 3) Unless otherwise indicated on the plans, all indoor switches located in utility areas shall be NEMA 12.
- c. Shall be finished with manufacturer's standard gray baked enamel paint over pretreated steel (for the type of enclosure required).

2.2 LOW VOLTAGE UNFUSED SWITCHES RATED 600 AMPERES AND LESS

Shall be the same as Low Voltage Fusible Switches Rated 600 Amperes and Less, but without provisions for fuses.

2.3 LOW VOLTAGE FUSIBLE SWITCHES RATED OVER 600 AMPERES TO 1200 AMPERES

Shall be the same as Low Voltage Fusible Switches Rated 600 Amperes and Less, except for the minimum duty rating which shall be NEMA classification Heavy Duty (HD). These switches shall also be HP rated.

2.4 MOTOR RATED TOGGLE SWITCHES

Refer to Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS.

2.5 LOW VOLTAGE CARTRIDGE FUSES

- A. In accordance with NEMA FU1.
- B. Motor Branch Circuits: Class RK1, time delay.
- C. Other Branch Circuits: Class RK1, time delay.
- D. Control Circuits: Class CC, time delay.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install disconnect switches in accordance with the NEC and as shown on the drawings.
- B. Fusible disconnect switches shall be furnished complete with fuses. Arrange fuses such that rating information is readable without removing the fuse.

3.2 SPARE PARTS

Two weeks prior to the final inspection, furnish one complete set of spare fuses for each fusible disconnect switch installed on the project. Deliver the spare fuses to the COR.

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SECTION 26 41 00
FACILITY LIGHTNING PROTECTION

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies the extension of an existing master labeled lightning protection system, complying with NFPA 780, UL 96 and UL 96A.

1.2 RELATED WORK

- A. Section 07 60 00, FLASHING AND SHEET METAL: penetrations through the roof.
- B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements that are common to more than one section of Division 26.
- C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path to ground for possible ground faults.

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:
- B. Shop Drawings:
 - 1. Isometric and plan views showing layout and connections to the required metal surfaces.
 - 2. Show the methods of mounting the system to the adjacent construction.
- C. Qualifications: Submit proof that the installer of the lightning protection system is a certified Lighting Protection Institute (LPI) installer, and has had suitable and adequate experience installing other lightning protection systems, and is capable of installing the system as recommended by the manufacturer of the equipment.
- D. Certification: Two weeks prior to final inspection, submit four copies of the following certifications to the COR:
 - 1. Certification that the lightning protection system has been properly installed and tested.
 - 2. Certification that the lightning protection system has been inspected by a UL representative and has been approved by UL without variation.

1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. National Fire Protection Association (NFPA):
 - 70-2011.....National Electrical Code (NEC)
 - 780.....Standard for the Installation of Lightning Protection Systems
- C. Underwriters Laboratories, Inc. (UL):
 - 96.....Lightning Protection Components
 - 96A.....Installation Requirements for Lightning Protection Systems
 - UL 467Standard for Grounding and Bonding Equipment

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Attach master labels to each item by its manufacturer as evidence that the materials have been manufactured in conformance with the UL Standards for master label lightning protection materials.
- B. In addition to conformance to UL 96, the component material requirements are as follows:
 - 1. Conductors: Electrical grade copper. Conductors shall be in accordance with NFPA 780 and UL 96 for Class I, Class II, or Class II modified materials as applicable.
 - 2. Air terminals: Solid copper, 18inches long, not less than 3/8 inch [9mm] diameter, with sharp nickel-plated points.
- C. Anchors and fasteners: Bolt type which are most suitable for the specific anchor and fastener installations. Clamp-type connectors for splicing conductors shall conform to UL 96, class as applicable, and, Class 2, style and size as required for the installation. Clamp-type connectors shall only be used for the connection of the roof conductor to the air terminal and to the guttering. All other connections, bonds, and splices shall be done by exothermic welds or by high compression fittings. The exothermic welds and high compression fittings shall be listed for the purpose. The high compression fittings shall be the type which require a hydraulically operated mechanism to apply a minimum of 10,000 psi.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be coordinated with the roofing manufacturer and installer.

- B. Install the conductors as inconspicuously as practical and with the proper bends.
- C. Make connections of dissimilar metal with bimetallic type fittings to prevent electrolytic action.
- D. Use the exothermic welding type connections that form solid metal joints in the main vertical and horizontal conductors, and for connections that are not exposed in the finish work.
- E. Sheath copper conductors, which pass over cast stone, cut stone, architectural concrete and masonry surfaces, with not less than a 1/16 inch [2mm] thickness of lead to prevent staining of the exterior finish surfaces.
- F. For structural steel buildings, connect the steel framework of the buildings to the main water pipe near the water system entrance to the building.
- G. Connect lightning protection cables to all metallic projections, equipment, and components above the roof as indicated on the drawings.
- H. Connect exterior metal surfaces, located within three feet [900mm] of the lightning protection system conductors, to the lightning protection system conductors to prevent flashovers.
- I. Maintain horizontal or downward coursing of main conductor and insure that all bends have at least an 8-inch radius and do not exceed 90 degrees.
- J. Conductors shall be rigidly fastened every three feet [900mm] along the roof and down to the building to ground.
- K. Air terminals shall be secured against overturning either by attachment to the object to be protected or by means of a substantial tripod or other braces permanently and rigidly attached to the building or structure. Install air terminal bases, cable holders and other roof-system supporting means without piercing roof metal.
- L. A counterpoise, where shown, shall be of No. 1/0 copper cable or equivalent material having suitable resistance to corrosion and shall be laid around the perimeter of the structure in a trench not less than 2 feet [600mm] deep at a distance not less than 3 feet [900mm] nor more than 8 feet [2.5m] from the nearest point of the structure.
- M. On construction utilizing post tensioning systems to secure precast concrete sections, the post tension rods shall not be used as a path for lightning to ground. Down conductors shall be provided on structures using post tensioning systems. Down conductors shall have sufficient separation from post tension rods to prevent side-flashing. Post tension rods shall be bonded to the lightning protection and grounding systems

only at the base of the structure; this bonding shall be performed in strict accordance with the recommendations of the post tension rod manufacturer, and shall be done by, or in the presence of, a representative of the manufacturer.

- N. Grounding: Test the ground resistance to earth by standard methods and conform to the ground resistance requirements specified in Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.
- O. Where shown, use the structural steel framework or reinforcing steel as the main conductor:
 - 1. Weld or bond the non-electrically-continuous sections together and make them electrically continuous.
 - 2. Verify the electrical continuity by measuring the ground resistances to earth at the ground level, at the top of the building or stack, and at intermediate points with a sensitive ohmmeter. Compare the resistance readings.
 - 3. Connect the air terminals together with an exterior conductor connected to the structural steel framework at not more than 60 foot [18m] intervals.
 - 4. Do not pierce the structural steel in any manner. Connections to the structural steel shall conform to UL Publication No. 96A.
- P. When the lightning protection systems have been installed, have the systems inspected by a UL representative. Obtain and install a UL numbered master label for each of the lightning protection systems at the location directed by the UL representative and the COR.

- - - E N D - - -

SECTION 26 43 13
TRANSIENT-VOLTAGE SURGE SUPPRESSION

PART 1 - GENERAL

1.1 DESCRIPTION

Section includes transient voltage surge suppression equipment for low-voltage power distribution and control equipment.

1.2 RELATED WORK

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General requirements that are common to more than one section of Division 26.

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. Include rated capacities, operating weights, electrical characteristics, furnished specialties, and accessories.
- B. Operation and Maintenance Data: For TVSS devices to include in emergency, operation, and maintenance manuals.
- C. Warranties: Sample of special warranties.
- D. Certifications:
1. Two weeks prior to final inspection, submit four copies of the following to the COTR:
 - a. Certification by the Contractor that the assemblies have been properly installed, adjusted and tested.
 - b. Certified copies of all of the factory design and production tests, field test data sheets and reports for the assemblies.

1.5 APPLICABLE PUBLICATIONS

Publications listed below (including amendments, addenda, revisions, supplement and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.

- A. Institute of Engineering and Electronic Engineers (IEEE):
- | | |
|--------------------|--|
| IEEE C62.41.2..... | Recommended Practice on Characterization
of Surges in Low-Voltage (1000 V and
Less) AC Power Circuits |
| IEEE C62.45..... | Recommended Practice on Surge Testing for
Equipment Connected to Low-Voltage (1000
V and Less) AC Power Circuits |

- B. National Electrical Manufacturers Association (NEMA):
 NEMA LS 1.....Low Voltage Surge Protective Devices
- C. Underwriters Laboratories, Inc. (UL):
 UL 1283.....Electromagnetic Interference Filters
 UL 1449.....Surge Protective Devices
- D. National Fire Protection Association (NFPA):
 NFPA 70-11.....National Electrical Code (NEC)

PART 2 - PRODUCTS

2.1 PANELBOARD SUPPRESSORS

- A. Surge Protection Devices:
 - 1. Non-modular.
 - 2. LED indicator lights for power and protection status.
 - 3. Audible alarm, with silencing switch, to indicate when protection has failed.
- B. Peak Single-Impulse Surge Current Rating: 100 kA per mode, 200 kA per phase.
- C. Minimum single impulse current ratings, using 8-by-20-mic.sec waveform described in IEEE C62.41.2:
 - 1. Line to Neutral: 100,000 A.
 - 2. Line to Ground: 100,000 A.
 - 3. Neutral to Ground: 100,000 A.
- D. Protection modes and UL 1449 SVR for grounded wye circuits shall be as follows:
 - 1. Line to Neutral: 400 V for 208Y/120 V.
 - 2. Line to Ground: 400 V for 208Y/120 V.
 - 3. Neutral to Ground: 400 V for 208Y/120 V.

2.2 ENCLOSURES

- A. Indoor Enclosures: NEMA 250 Type 1.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install TVSS devices at panelboard on load side, with ground lead bonded to service entrance ground.
- B. Install TVSS devices for panelboards and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
 - 1. Provide a circuit breaker, sized by manufacturer, as a dedicated disconnecting means for TVSS unless otherwise shown on drawings.

3.2 ACCEPTANCE CHECKS AND TESTS

- A. Perform in accordance with the manufacturer's recommendations. Include the following visual and mechanical inspections and electrical tests:
 - 1. Visual and Mechanical Inspection
 - a. Compare equipment nameplate data with specifications and approved shop drawings.
 - b. Inspect physical, electrical, and mechanical condition.
 - c. Verify that disconnecting means and feeder size and maximum to TVSS unit correspond to approved shop drawings.
 - d. Verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method.
 - e. Clean TVSS unit.
 - f. Complete startup checks according to manufacturer's written instructions.
 - g. Verify the correct operation of all sensing devices, alarms, and indicating devices.

3.3 STARTUP

- A. Do not energize or connect panelboards to their sources until TVSS devices are installed and connected.
- B. Do not perform insulation resistance tests of the distribution wiring equipment with the TVSS installed. Disconnect before conducting insulation resistance tests, and reconnect immediately after the testing is over.

3.4 SPARE PARTS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Replaceable Protection Modules: One of each size and type installed.

3.5 INSTRUCTION

Provide factory certified technician to train Government maintenance personnel to maintain TVSS devices. Training shall be provided for a total period of 4 hours of normal working time and shall start after the system is functionally complete but prior to final acceptance test. Training shall cover all essential items contained in the operation and maintenance manual.

- - -END OF SECTION - - -

SECTION 26 51 00
INTERIOR LIGHTING

PART 1 - GENERAL

1.1 DESCRIPTION:

This section specifies the furnishing, installation and connection of the interior lighting systems.

1.2 RELATED WORK

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General requirements that are common to more than one section of Division 26.
- B. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Cables and wiring.
- C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path to ground for possible ground fault currents.
- D. Section 26 27 26, WIRING DEVICES: Wiring devices used for control of the lighting systems.

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:
- B. Product Data: For each type of lighting fixture (luminaire) designated on the LIGHTING FIXTURE SCHEDULE, arranged in order of fixture designation, submit the following information.
 - 1. Material and construction details include information on housing, optics system and lens/diffuser.
 - 2. Physical dimensions and description.
 - 3. Wiring schematic and connection diagram.
 - 4. Installation details.
 - 5. Energy efficiency data.
 - 6. Photometric data based on laboratory tests complying with IESNA Lighting Measurements, testing and calculation guides.
 - 7. Lamp data including lumen output (initial and mean), color rendition index (CRI), rated life (hours) and color temperature (degrees Kelvin).
 - 8. Ballast data including ballast type, starting method, ambient temperature, ballast factor, sound rating, system watts and total harmonic distortion (THD).

9. Light Emitting Diode:

- a. Luminaire photometric report indicated above shall also be per IESNA LM-79-08.
- b. Provide documentation showing a minimum of 6,000 hours of continuous operation of the LEDs at three different temperatures per LM-80-08.
- c. Provide documentation of the expected useful life as defined below including the testing and calculation of useful life and verification of site lighting performance at that life. If the Site defined performance method is used, document the use of LM-80 test data, the specific extrapolation procedure used, the interpolation between the three sets of LM-80 data, and all calculations applied in deriving the proposed LLD and useful life.
- d. Provide safety certification and file number as required for the luminaire family which shall be listed, labeled, or identified per the National Electric Code (NEC). Applicable testing bodies are determined by the US Occupational Safety Health Administration (OSHA) as Nationally Recognized Testing Laboratories (NRTL) and include: CSA (Canadian Standards Association), ETL (Edison Testing Laboratory), and UL (Underwriters Laboratory).

C. Manuals:

1. Submit, simultaneously with the shop drawings companion copies of complete maintenance and operating manuals including technical data sheets, and information for ordering replacement parts.
2. Two weeks prior to the final inspection, submit four copies of the final updated maintenance and operating manuals, including any changes, to the COR.

D. Certifications:

1. Two weeks prior to final inspection, submit four copies of the following certifications to the COR:
 - a. Certification by the Contractor that the equipment has been properly installed, adjusted, and tested.

1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. Institute of Electrical and Electronic Engineers (IEEE):

C62.41-91.....Guide on the Surge Environment in Low Voltage
(1000V and less) AC Power Circuits

- C. National Fire Protection Association (NFPA):
 - 70-11.....National Electrical Code (NEC)
 - 101.....Life Safety Code
- D. National Electrical Manufacturer's Association (NEMA):
 - C82.1-97.....Ballasts for Fluorescent Lamps - Specifications
 - C82.2-02.....Method of Measurement of Fluorescent Lamp
Ballasts
 - C82.4-02.....Ballasts for High-Intensity-Discharge and Low-
Pressure Sodium Lamps
 - C82.11-02.....High Frequency Fluorescent Lamp Ballasts
- E. Underwriters Laboratories, Inc. (UL):
 - 496-96.....Edison-Base Lampholders
 - 542-99.....Lampholders, Starters, and Starter Holders for
Fluorescent Lamps
 - 844-95.....Electric Lighting Fixtures for Use in Hazardous
(Classified) Locations
 - 924-95.....Emergency Lighting and Power Equipment
 - 935-01.....Fluorescent-Lamp Ballasts
 - 1029-94.....High-Intensity-Discharge Lamp Ballasts
 - 1029A-06.....Ignitors and Related Auxiliaries for HID Lamp
Ballasts
 - 1598-00.....Luminaires
 - 1574-04.....Standard for Track Lighting Systems
 - 2108-04.....Standard for Low-Voltage Lighting Systems
 - 8750-08.....Light Emitting Diode (LED) Light Sources for Use
in Lighting Products
- F. Federal Communications Commission (FCC):
 - Code of Federal Regulations (CFR), Title 47, Part 18

PART 2 - PRODUCTS

2.1 LIGHTING FIXTURES (LUMINAIRES)

- A. Shall be in accordance with NFPA 70 and UL 1598, as shown on drawings, and as specified.
- B. Sheet Metal:
 - 1. Shall be formed to prevent warping and sagging. Housing, trim and lens frame shall be true, straight (unless intentionally curved) and parallel to each other as designed.
 - 2. Wireways and fittings shall be free of burrs and sharp edges and shall accommodate internal and branch circuit wiring without damage to the wiring.

3. When installed, any exposed fixture housing surface, trim frame, door frame and lens frame shall be free of light leaks; lens doors shall close in a light tight manner.
 4. Hinged door closure frames shall operate smoothly without binding when the fixture is in the installed position, latches shall function easily by finger action without the use of tools.
- C. Ballasts shall be serviceable while the fixture is in its normally installed position, and shall not be mounted to removable reflectors or wireway covers unless so specified.
- D. Lamp Sockets:
1. Fluorescent: Lampholder contacts shall be the biting edge type or phosphorous-bronze with silver flash contact surface type and shall conform to the applicable requirements of UL 542. Lamp holders for bi-pin lamps shall be of the telescoping compression type, or of the single slot entry type requiring a one-quarter turn of the lamp after insertion.
 2. High Intensity Discharge (H.I.D.): Shall have porcelain enclosures.
- E. Recessed fixtures mounted in an insulated ceiling shall be listed for use in insulated ceilings.
- F. Mechanical Safety: Lighting fixture closures (lens doors, trim frame, hinged housings, etc.) shall be retained in a secure manner by captive screws, chains, captive hinges or fasteners such that they cannot be accidentally dislodged during normal operation or routine maintenance.
- G. Metal Finishes:
1. The manufacturer shall apply standard finish (unless otherwise specified) over a corrosion resistant primer, after cleaning to free the metal surfaces of rust, grease, dirt and other deposits. Edges of pre-finished sheet metal exposed during forming, stamping or shearing processes shall be finished in a similar corrosion resistant manner to match the adjacent surface(s). Fixture finish shall be free of stains or evidence of rusting, blistering, or flaking, and shall be applied after fabrication.
 2. Interior light reflecting finishes shall be white with not less than 85 percent reflectances, except where otherwise shown on the drawing.
 3. Exterior finishes shall be as shown on the drawings.
- H. Lighting fixtures shall have a specific means for grounding metallic wireways and housings to an equipment grounding conductor.
- I. Light Transmitting Components for Fluorescent Fixtures:
1. Shall be 100 percent virgin acrylic.

2. Flat lens panels shall have not less than 1/8 inch [3.2mm] of average thickness. The average thickness shall be determined by adding the maximum thickness to the minimum unpenetrated thickness and dividing the sum by 2.
 3. Unless otherwise specified, lenses, diffusers and louvers shall be retained firmly in a metal frame by clips or clamping ring in such a manner as to allow expansion and contraction of the lens without distortion or cracking.
- J. Compact fluorescent fixtures shall be manufactured specifically for compact fluorescent lamps with ballast integral to the fixture. Assemblies designed to retrofit incandescent fixtures are prohibited except when specifically indicated for renovation of existing fixtures (not the lamp). Fixtures shall be designed for lamps as specified.

2.2 BALLASTS

- A. Linear Fluorescent Lamp Ballasts: Multi-voltage (120 - 277V) electronic programmed-start type, complying with UL 935 and with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated; including the following features:
1. Lamp end-of-life detection and shutdown circuit (T5 lamps only).
 2. Automatic lamp starting after lamp replacement.
 3. Sound Rating: Class A.
 4. Total Harmonic Distortion Rating: 10 percent or less.
 5. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
 6. Operating Frequency: 20 kHz or higher.
 7. Lamp Current Crest Factor: 1.7 or less.
 8. Ballast Factor: 0.87 or higher unless otherwise indicated on the drawings.
 9. Power Factor: 0.98 or higher.
 10. Interference: Comply with 47 CFT 18, Ch.1, Subpart C, for limitations on electromagnetic and radio-frequency interference for non-consumer equipment.
 11. To facilitate multi-level lamp switching, lamps within fixture shall be wired with the outermost lamp at both sides of the fixture on the same ballast, the next inward pair on another ballast and so on to the innermost lamp (or pair of lamps). Within a given room, each switch shall uniformly control the same corresponding lamp (or lamp pairs) in all fixture units that are being controlled.

12. Where three-lamp fixtures are indicated, unless switching arrangements dictate otherwise, utilize a common two-lamp ballast to operate the center lamp in pairs of adjacent units that are mounted in a continuous row. The ballast fixture and slave-lamp fixture shall be factory wired with leads or plug devices to facilitate this circuiting. Individually mounted fixtures and the odd fixture in a row shall utilize a single-lamp ballast for operation of the center lamp.
 13. Dimming ballasts shall be as per above, except dimmable from 100% to 5% of rated lamp lumens.
- B. Compact Fluorescent Lamp Ballasts: Multi-voltage (120 - 277V), electronic-programmed rapid-start type, complying with UL 935 and with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated; including the following features:
1. Lamp end-of-life detection and shutdown circuit.
 2. Automatic lamp starting after lamp replacement.
 3. Sound Rating: Class A.
 4. Total Harmonic Distortion Rating: 10 percent or less.
 5. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
 6. Operating Frequency: 20 kHz or higher.
 7. Lamp Current Crest Factor: 1.7 or less.
 8. Ballast Factor: 0.95 or higher unless otherwise indicated on the drawings.
 9. Power Factor: 0.98 or higher.
 10. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for non-consumer equipment.
 11. Dimming ballasts shall be as per above, except dimmable from 100% to 5% of rated lamp lumens.
- C. Electronic Light Emitting Diode (LED) Drivers:
1. General.
 - a. Comply with the latest version of the following:
 - 1) Underwriters Laboratory (UL935), Class P, Type 1 Outdoor or Type 2 Indoor listed.
 - 2) ANSI C62.41 - IEEE Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits, 1991, Category A Transient Protection limits.

- 3) FCC CFR 47, Part 18 Non-Consumer Equipment, Class A for EMI (conducted) and RFI (radiated) limits
2. Single voltage driver shall operate:
 - a. From an input frequency of 60 hertz.
 - b. From an input voltage of 120 volts or 277 volts.
 - c. With sustained variations of plus or minus 10 percent voltage and frequency with no damage to the ballast.
3. Multi-volt sensing ballast shall operate:
 - a. From an input frequency of 50/60 hertz.
 - b. From an input voltage of 120 volts through 277 volts.
 - c. With sustained variations of plus or minus 10 percent voltage and frequency with no damage to the ballast.
4. Power Factor (PF): greater than 90 percent.
5. Total Harmonic Distortion (THD): less than 20 percent for primary lamp application.
6. Lamp Current Crest Factor (LCCF): less than 1.5.
7. Minimum driver efficiency of 80 percent.
8. Contain no Polychlorinated Biphenyl (PCB).
9. Class A sound rating.
10. Contain auto-restart circuitry in order to restart lamps without resetting power.
11. Tolerate sustained open circuit and short circuit output conditions without damage.
12. Shall be Reduction of Hazardous Substances (RoHS) compliant.
www.rohs.eu/english/index.htm

2.3 LAMPS

- A. Linear and U-shaped T5 and T8 Fluorescent Lamps:
 1. Rapid start fluorescent lamps shall comply with ANSI C78.1; and instant-start lamps shall comply with ANSI C78.3.
 2. Chromacity of fluorescent lamps shall comply with ANSI C78.376.
 3. Except as indicated below, lamps shall be low-mercury energy saving type, have a color temperature 4100°K, a Color Rendering Index (CRI) of greater than 80, average rated life of 20,000 hours, and be suitable for use with dimming ballasts, unless otherwise indicated. Low mercury lamps shall have passed the EPA Toxicity Characteristic Leachate Procedure (TCLP) for mercury by using the lamp sample preparation procedure described in NEMA LL
- B. Compact Fluorescent Lamps:
 1. T4, CRI 80 (minimum), color temperature 3500 K, and suitable for use with dimming ballasts, unless otherwise indicated.

C. Light Emitting Diode (LED)

1. General.
 - a. Lamp shape and base, bar.
 - b. Meets Federal minimum for efficiency standards.
 - c. EPA Toxicity Characteristic Leaching Procedure (TCLP) compliant.
 - d. Lumen maintenance, per LM-80.
 - e. Color Rendering Index (CRI), greater than 65.
 - f. Correlated Color Temperature (CCT), 5000 Kelvin.
2. Nominal wattage and length.
 - a. 72 watts for 72 lamps.
 - b. 84 watts for 84 lamps.
 - c. 96 watts for 96 lamps.
 - d. 108 watts for 108 lamps.
 - e. 120 watts for 120 lamps.
 - f. 132 watts for 132 lamps.
 - g. 144 watts for 144 lamps.
3. Initial Lumens.
 - a. 6,200 lumens for 72 watts.
 - b. 8,000 lumens for 84 watts.
 - c. 12,000 lumens for 96 watts.
 - d. 17,000 lumens for 108 watts.
 - e. 15,572 lumens for 120 watts.
 - f. 27,000 lumens for 132 watts.
 - g. 36,000 lumens for 144 watts.
4. Average rated life, 50,000 hours.
5. Luminaire manufacturer shall submit reliability reports indicating that the manufacturer of the LED (chip, diode, or package) has performed JEDEC (Joint Electron Devices Engineering Council) reliability tests on the LEDs as follows:
 - a. High Temperature Operating Life (HTOL).
 - b. Room Temperature Operating Life (RTOL).
 - c. Low Temperature Operating Life (LTOL).
 - d. Powered Temperature Cycle (PTMCL).
 - e. Non-Operating Thermal Shock (TMSK).
 - f. Mechanical Shock.
 - g. Variable Vibration Frequency.
 - h. Solder Heat Resistance (SHR).

6. For Light Emitting Diode (LED) lamps.
 - a. General requirements.
 - 1) Minimum starting temperature of minus 40 degrees Celsius (40 degrees Fahrenheit).
 - 2) Operate lamps at frequency of 60 hertz or higher.
 - 3) Designed for use with occupancy sensors by providing 50,000 starts minimum.

2.4 EXIT LIGHT FIXTURES

- A. Exit light fixtures shall meet applicable requirements of NFPA 101 and UL 924.
- B. Housing and Canopy:
 1. Shall be made of die-cast aluminum, matte black finish.
- C. Door frame shall be cast or extruded aluminum, and hinged with latch.
- D. Finish shall be satin or fine-grain brushed aluminum.
- E. There shall be no radioactive material used in the fixtures.
- F. Fixtures:
 1. Maximum fixture wattage shall be 1 watt or less.
 2. Inscription panels shall be cast or stamped aluminum a minimum of 0.090 inch [2.25mm] thick, stenciled with 6 inch [150mm] high letters, baked with red color stable plastic or fiberglass. Lamps shall be luminous Light Emitting Diodes (LED) mounted in center of letters on red color stable plastic or fiberglass. The LED shall be rated minimum 25 years life.
 3. Double-Faced Fixtures: Provide double-faced fixtures where required or as shown on drawings.
 4. Directional Arrows: Provide directional arrows as part of the inscription panel where required or as shown on drawings. Directional arrows shall be the "chevron-type" of similar size and width as the letters and meet the requirements of NFPA 101.
- G. Voltages: Refer to Lighting Fixture Schedule.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be in accordance with the NEC, manufacturer's instructions and as shown on the drawings or specified.
- B. Align, mount and level the lighting fixtures uniformly.
- C. Lighting Fixture Supports:
 1. Shall provide support for all of the fixtures. Supports may be anchored to channels of the ceiling construction, to the structural slab or to structural members within a partition, or above a suspended ceiling.

2. Shall maintain the fixture positions after cleaning and relamping.
3. Shall support the lighting fixtures without causing the ceiling or partition to deflect.
4. Hardware for recessed fluorescent fixtures:
 - a. Where the suspended ceiling system is supported at the four corners of the fixture opening, hardware devices shall clamp the fixture to the ceiling system structural members, or plaster frame at not less than four points in such a manner as to resist spreading of the support members and safely lock the fixture into the ceiling system.
 - b. Where the suspended ceiling system is not supported at the four corners of the fixture opening, hardware devices shall independently support the fixture from the building structure at four points.
5. Hardware for surface mounting fluorescent fixtures to suspended ceilings:
 - a. In addition to being secured to any required outlet box, fixtures shall be bolted to a grid ceiling system at four points spaced near the corners of each fixture. The bolts shall be not less than 1/4 inch [6mm] secured to channel members attached to and spanning the tops of the ceiling structural grid members. Non-turning studs may be attached to the ceiling structural grid members or spanning channels by special clips designed for the purpose, provided they lock into place and require simple tools for removal.
 - b. In addition to being secured to any required outlet box, fixtures shall be bolted to ceiling structural members at four points spaced near the corners of each fixture. Pre-positioned 1/4 inch [6mm] studs or threaded plaster inserts secured to ceiling structural members shall be used to bolt the fixtures to the ceiling. In lieu of the above, 1/4 inch [6mm] toggle bolts may be used on new or existing ceiling provided the plaster and lath can safely support the fixtures without sagging or cracking.
- D. Furnish and install the specified lamps for all lighting fixtures installed and all existing lighting fixtures reinstalled under this project.
- E. Coordinate between the electrical and ceiling trades to ascertain that approved lighting fixtures are furnished in the proper sizes and installed with the proper devices (hangers, clips, trim frames, flanges), to match the ceiling system being installed.

- F. Bond lighting fixtures and metal accessories to the grounding system as specified in Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.
- G. Exercise electronic dimming ballasts over full range of dimming capability by operating the control devices(s) in the presence of the COR. Observe for visually detectable flicker over full dimming range.
- H. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by Government. Burn-in period to be 40 hours minimum, unless a lesser period is specifically recommended by lamp manufacturer. Burn-in fluorescent and compact fluorescent lamps intended to be dimmed, for at least 100 hours at full voltage. Replace any lamps and ballasts which fail during burn-in.
- I. At completion of project, relamp/reballast fixtures which have failed lamps/ballasts. Clean fixtures, lenses, diffusers and louvers that have accumulated dust/dirt/fingerprints during construction. Replace damaged lenses, diffusers and louvers with new.
- J. Dispose of lamps per requirements of Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.

- - - E N D - - -

Ann Arbor VAMC Network Cabling

Basic Specifications and Equipment List

Lewis G. Bussard
Network Engineer
734.845.3949

Ann Arbor VAMC
(CIO/40)
2215 Fuller Road
Ann Arbor, MI 48105

Last Review Date: 13 October 2010

Ann Arbor VAMC Network Cabling

1.0 Overview

- a. The installer shall be trained and certified on national and local regulations, plus the contractor shall be trained and certified on and adhere to the standards of the telecommunications and building industries. Contractor shall required to have at least one lead person that is a BICSI certified RCDD.

1.1 Agencies

- A The following agencies and their codes, standards and regulations shall govern all telecommunications work performed at the Ann Arbor VAMC.
 - ANSI American National Standards Institute
 - BICSI Building Industry Consulting Service International
 - BOCA Building Officials and Code Administrators (Standard Building Code)
 - EIA Electronic Industries Association
 - FCC Federal Communications Commission
 - FOTP Fiber Optic Testing Procedures
 - ICBO International Conference of Building Officials (Uniform Building Code)
 - IEEE Institute of Electrical and Electronic Engineers, Inc
 - NBC National Building Code
 - NFPA National Fire Protection Association
 - NEC National Electrical Code 2011
 - RUS Rural Utilities Services
 - TIA Telecommunications Industry Association
 - UL Underwriters Laboratories

1.2 Backbone Cabling

A. Cable

1. All optical fiber, copper and coaxial backbone cable manufacturers and sizes will be approved by CNS prior to installation. A 50 percent growth factor shall be built in and provided for in all backbone cable unless otherwise specified. Consequently, any cable work that pertains to telecommunications must be designed and/or approved by Ann Arbor VAMC Network Engineer.
2. Substitutions: Or equal with similar and salient characteristics. Submit in format noted in VAAR 811.104-71(b) and provide the required information on “equal” products, and to provide descriptive literature in accordance with FAR 52.14-21.
3. Alternates must be pre-approved by Ann Arbor VAMC Network Engineer.

B. Termination

1. All copper pairs and fiber strands in backbone cables shall be 100% terminated unless otherwise directed by Ann Arbor VAMC Network Engineer. Terminated fiber strands will be installed in rack mounted optical fiber distribution shelves. Telephone multi-pair copper backbone cables shall be terminated onto wall mounted 110 blocks, unless a 66 block is specifically requested or required for a project. Data copper cabling shall be terminated on a certified (for type cable) patch panel.

Ann Arbor VAMC Network Cabling

C. Labeling

1. All labels shall be self laminating and machine generated (no hand written labels). All horizontal cables shall be labeled at both ends with self-laminating labels. Labels shall be no closer than 4 inches and no further than 6 inches back from the termination of the cable. Labels shall be XXX-XXXXX (Jack- Room Number, in rooms with multiple outlets, label clockwise as you enter the room: e.g. a data port at the first drop location to the left of room B544 door would be – 231-B544). Reference TIA/EIA-606-A document. Labeling presented here is based on Ann Arbor VAMC Building 1, clinic cabling (leased space) will be allowed variance, but still shall be TIA/EIA-606-A compliant.
2. The label shall contain the following information:
 - The Origination (TR it is feeding from).
 - The Destination (TR it is feeding).
 - Number of pairs or fibers
3. Ann Arbor VAMC Network Engineer will approve all labeling schematics prior to installation, remote CBOCS and Annex locations will vary by building configuration.
4. A small CBOC with a single communications closet and one floor:
 - Numbered with 001 to 999 starting from the front of the building and running clockwise through the rooms. Within a room is also clockwise for numbering.
 - Telephone jack numbering is independent of data jack numbering.
5. All modular outlets shall be identified color as to their use, see chart for colors.
6. All Room Wall Plates shall follow the Ann Arbor VAMC labeling convention based on if facility is a hospital or CBOC:
7. Data
 - Port#-1W-5N-Port#
 - 231-1W-5N-232 where 1W is building and 5N represents the floor and closet.
 - a. Substitutions: Or equal with similar and salient characteristics. Submit in format noted in VAAR 811.104-71(b) and provide the required information on “equal” products, and to provide descriptive literature in accordance with FAR 52.14-21.
 - b. Alternates must be pre-approved by Ann Arbor VAMC Network Engineer.
8. Voice
 - Phone Cable-1W-5N-Phone Cable
 - 1023-1W-5N-1024
 - These relate to phone pairs, not like data jacks.
 - a. Substitutions: Or equal with similar and salient characteristics. Submit in format noted in VAAR 811.104-71(b) and provide the required information on “equal” products, and to provide descriptive literature in accordance with FAR 52.14-21.
 - b. Alternates must be pre-approved by Ann Arbor VAMC Network Engineer.

Ann Arbor VAMC Network Cabling

The contractor shall provide an "As-Built" drawing (both electronic and printed) with all outlets identified for each room with jack numbers shall be provided.

1.3 Horizontal Cabling

A. Cable

1. All voice and data station wiring shall be continuous (no splices) from the nearest TR cross connect to the communication outlet.
 - Final approval for the layout of jack outlets shall rest with Ann Arbor VAMC Network Engineer.
 - Data – 4 pair 100Ω Category 6a UTP cable.
 - Voice – 4 pair 100Ω Category 5e UTP cable.
 - Cable runs shall be in accordance with TIA/EIA 568 latest Revisions
 - All cable terminations shall be TIA-568A pin out.
 - Cabling shall be plenum or non-plenum as required by the facility where cable is being installed.
 - All Cable runs shall be in cable trays or properly suspended and supported. No cable runs shall rest on the drop ceiling. Floors that have access via the interstitial space shall have cables properly routed through that area and related cable management, following facility requirements.
 - Ann Arbor VAMC Network Engineer shall approve all proposed runs before work is done, to insure they meet facility requirements for cabling.
2. Substitutions: Or equal with similar and salient characteristics. Submit in format noted in VAAR 811.104-71(b) and provide the required information on “equal” products, and to provide descriptive literature in accordance with FAR 52.14-21.
3. Alternates must be pre-approved by Ann Arbor VAMC Network Engineer.

Note: No Non CAT-6a cabling is allowed for Data.

B. Termination

1. All horizontal cabling shall be 100% terminated.
2. Data and voice horizontal cables will be terminated onto eight (8) position modular outlets at the workstation, and onto rack mounted patch panels in the TR.
3. The total wire path length from the outlet to the Telecommunications room must not exceed 275 feet in any case. This is important to meet Ethernet requirements of IEEE 802.3.
 - Modular outlets shall be the following colors as a standard for Ann Arbor VAMC:
 - Data Jacks are Black
 - Voice Jacks are Ivory
 - All faceplates are Ivory in color, 4 positions, with any unused positions plugged with a blank insert of the same color.
 - All Data Cables shall be terminated TIA568A
 - All Cables shall be tested in accordance with TIA/EIA TSB-67, Latest Revision.

Ann Arbor VAMC Network Cabling

- Wireless Access Point ceiling drops shall have 10 foot of extra cable coiled and tie wrapped up so AP units can be moved to fine tune coverage.

C. Communications Outlets

1. Ann Arbor VAMC Network Engineer has defined a standard communications outlet which consists of three (3) 4 pair 100Ω Category 6a or higher UTP cables. Two (2) cables will be blue in color and be terminated for data connections. The third cable will be white in color and be terminated for voice connection. Exceptions to this will be building and user specific and identified in the design stage.

D. Documentation and Testing

1. All cable runs shall be tested in accordance with TSB-67 and TIA/EIA 568-A or latest TIA/EIA Revisions. A copy of the test results shall be provided to the Network Engineer in electronic format that can be displayed and/or viewed. Cable length shall be included in this report.
2. Contractor or vendor shall provide electronic documentation of all cable tests, Excel spreadsheet of patch panel port to room configuration and a marked up “as built” drawing showing location and jack numbers for each room.

E. Cable Specifications

1. Horizontal Cabling

- UTP 4/24 Category 6a PVC Cable (White) Voice
- UTP 4/24 Category 5e PVC Cable (Blue) Data

Note: Plenum shall be used where required; Cabling contractor shall verify what cable type is required for a given area with facility owner or engineer.

2. Substitutions: Or equal with similar and salient characteristics. Submit in format noted in VAAR 811.104-71(b) and provide the required information on “equal” products, and to provide descriptive literature in accordance with FAR 52.14-21.
3. Alternates must be pre-approved by Ann Arbor VAMC Network Engineer.

F. Wall Location Boxes

1. Wall boxes for data and phone drops shall be 4”x4”x2.5” unless a single gang unit is specified.
2. Single gang boxes shall be 2”x4”x2.5”
3. Conduits to the box shall be 1” in diameter, may be ¾” if approved by Ann Arbor VAMC Network Engineer for single gang boxes.

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G. Cable Color Codes

1. This applies to CAT 6A, CAT 5e (Phone Only), Coax and other wiring types.

- Blue Network Data Cables
- White Phone Cables
- Green Patient Monitor Equipment Network (Wall Jacks also Green)
- Red Fire Alarm
- Gray PA, Nurse Call and Panic Alarm
- Black Security, Video (CCTV and IP Cameras) and other Security functions.

Ann Arbor VAMC Network Cabling

2. Wall Plate, Connector and Patch Panel Specifications

QuickPort Wallplate, Dual- Gang, 6 port with Designation Windows	Leviton	42080-6IP
QuickPort Wallplate, Single-Gang, 4 port with Designation Windows	Leviton	42080-4IS
Data QuickPort snap in connector for UTP Copper Cable, Black Color	Leviton	61110-RB6 CAT 6a
Voice QuickPort snap in connector for UTP Copper Cable, Ivory Color	Leviton	61110-RI6 CAT 6a
Patient Monitoring QuickPort snap in connector for UTP Copper Cable, Green Color	Leviton	61110-RV6 CAT 6a
Patient Internet Access QuickPort snap in connector for UTP Copper Cable, Yellow Color	Leviton	61110-RY6 CAT 6a
Patch Panel, 24 port	Leviton	69586-U24 CAT 6a
Patch Panel, 48 port	Leviton	69586-U48 CAT 6a
Horizontal Cable Manager, 2RU, 4" metal rings	Leviton	49253-BCM
Horizontal Cable Manager, 1RU, 4" metal rings	Leviton	49253-LPM
CAT 6a 110-Style Wiring Block Kits	Leviton	41AB6-3F4
CAT 6 Labeling Kit, 6/Kit	Leviton	41LBL-60W
Label Holder, t/Kit	Leviton	41100-HDL
TC Fiber Rack Mount Enclosure – 1U	Leviton	RDP1U-S03
Rack Mount Power Distribution	Leviton	5500-192
Voice QuickPort snap in connector for UTP Copper Cable, Ivory Color	Leviton	5G109-RI5 Cat5e

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The jack and pin/pair assignments for these modular jacks are shown in the illustrations below. These assignments are compatible with all known data applications intended to operate over 100-ohm twisted-pair cable.

**Eight-Position Jack Pin/Pair Assignments (T568A)
(Front View of Connector)**

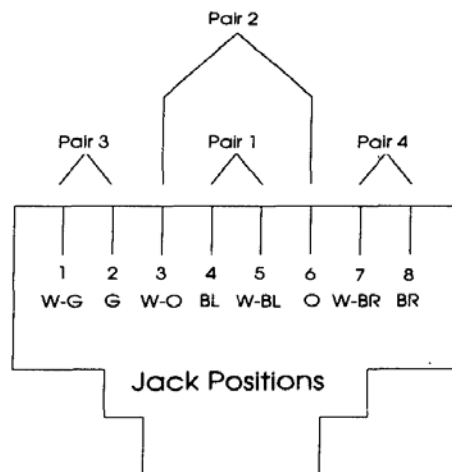


Figure 1 TIA 568A Pin outs and Color Code

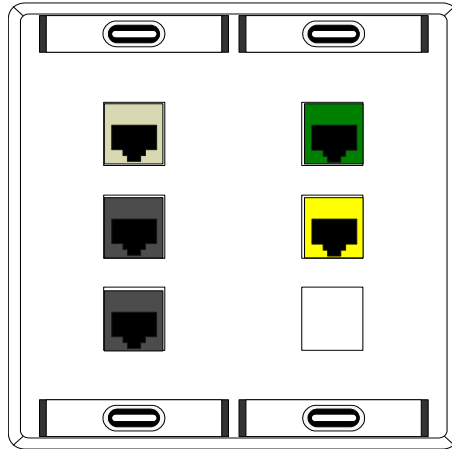


Figure 2 Typical Wall Plate Layout – Dual Gang

Ann Arbor VAMC Network Cabling

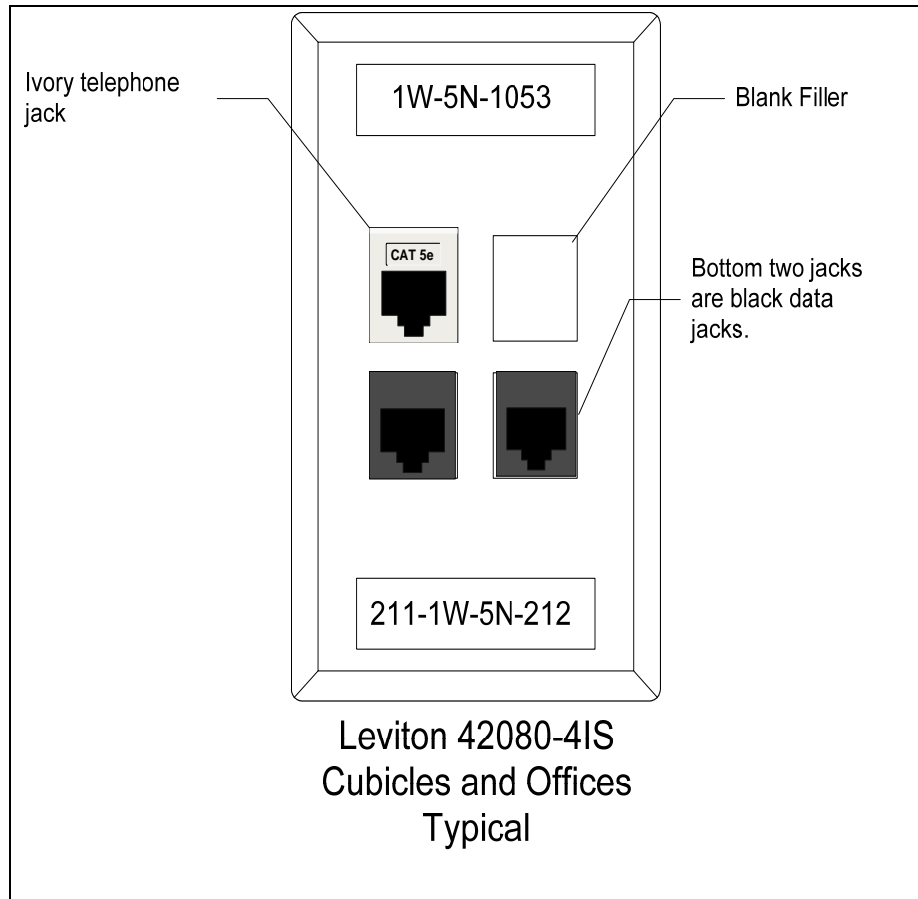


Figure 3 Typical Wall Plate Layout – Single Gang

Ann Arbor VAMC Network Cabling

AFF	Above Finished Floor
AWG	American Wire Gage
BDF	Building Distribution Frame
CDF	Combined Distribution Frame
CNS	Communications & Network Systems
DOWELED	Drilled hole for rebar
ECL	Type of token ring connector
EMT	Electrical Metallic Tubing
FC	Foot-candle
HVAC	Heating, Ventilation and Air Conditioning
Hz	Hertz
IBM	International Business Machines
IDF	Intermediate Distribution Frame
LAN	Local Area Network
OHM	Unit of resistance
OSP	Outside Plant
PBX	Private Branch Exchange
PVC	Type of conduit
SF	Square foot
TR	Telecommunications Room
TT	Text Telephone (formally TDD)
WAN	Wide Area Network

SECTION 27 05 11

REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section, Requirements for Communications Installations, applies to all sections of Division 27.
- B. Furnish and install communications cabling, systems, equipment, and accessories in accordance with the specifications and drawings. Capacities and ratings of transformers, cable, and other items and arrangements for the specified items are shown on drawings.

1.2 MINIMUM REQUIREMENTS

- A. References to industry and trade association standards and codes are minimum installation requirement standards.
- B. Drawings and other specification sections shall govern in those instances where requirements are greater than those specified in the above standards.

1.3 QUALIFICATIONS (PRODUCTS AND SERVICES)

- A. Manufacturers Qualifications: The manufacturer shall regularly and presently produce, as one of the manufacturer's principal products, the equipment and material specified for this project, and shall have manufactured the item for at least three years.
- B. Product Qualification:
 - 1. Manufacturer's product shall have been in satisfactory operation, on three installations of similar size and type as this project, for approximately three years.
 - 2. The Government reserves the right to require the Contractor to submit a list of installations where the products have been in operation before approval.
- C. Service Qualifications: There shall be a permanent service organization maintained or trained by the manufacturer which will render satisfactory service to this installation within 24 hours of receipt of notification that service is needed. Submit name and address of service organizations.

1.4 MANUFACTURED PRODUCTS

- A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts shall be available.
- B. When more than one unit of the same class of equipment is required, such units shall be the product of a single manufacturer.
- C. Equipment Assemblies and Components:
 - 1. Components of an assembled unit need not be products of the same manufacturer.
 - 2. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.
 - 3. Components shall be compatible with each other and with the total assembly for the intended service.
 - 4. Constituent parts which are similar shall be the product of a single manufacturer.
- D. Factory wiring shall be identified on the equipment being furnished and on all wiring diagrams.
- E. When Factory Testing Is Specified:
 - 1. The Government shall have the option of witnessing factory tests. The Contractor shall notify the VAMC through the Contracting Officer's Technical Representative (COR) a minimum of 15 working days prior to the manufacturers making the factory tests.
 - 2. Four copies of certified test reports containing all test data shall be furnished to the COR prior to final inspection and not more than 90 days after completion of the tests.
 - 3. When equipment fails to meet factory test and re-inspection is required, the contractor shall be liable for all additional expenses, including expenses of the Government.

1.5 EQUIPMENT REQUIREMENTS

Where variations from the contract requirements are requested in accordance with GENERAL CONDITIONS and Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, the connecting work and related components shall include, but not be limited to additions or changes to branch circuits, circuit protective devices, conduits, wire, feeders, controls, panels and installation methods.

1.6 EQUIPMENT PROTECTION

- A. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, moisture, cold and rain:
 - 1. During installation, enclosures, equipment, controls, controllers, circuit protective devices, and other like items, shall be protected against entry of foreign matter; and be vacuum cleaned both inside and outside before testing and operating and repainting if required.
 - 2. Damaged equipment shall be, as determined by the COR, placed in first class operating condition or be returned to the source of supply for repair or replacement.
 - 3. Painted surfaces shall be protected with factory installed removable heavy kraft paper, sheet vinyl or equal.
 - 4. Damaged paint on equipment and materials shall be refinished with the same quality of paint and workmanship as used by the manufacturer so repaired areas are not obvious.

1.7 WORK PERFORMANCE

- A. Jobsite safety and worker safety is the responsibility of the contractor.
- B. For work on existing stations, arrange, phase and perform work to assure communications service for other buildings at all times. Refer to Article OPERATIONS AND STORAGE AREAS under Section 01 00 00, GENERAL REQUIREMENTS.
- C. New work shall be installed and connected to existing work neatly and carefully. Disturbed or damaged work shall be replaced or repaired to its prior conditions, as required by Section 01 00 00, GENERAL REQUIREMENTS.
- D. Coordinate location of equipment and pathways with other trades to minimize interferences.

1.8 EQUIPMENT INSTALLATION AND REQUIREMENTS

- A. Equipment location shall be as close as practical to locations shown on the drawings.
- B. Inaccessible Equipment:
 - 1. Where the Government determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, the equipment shall be removed and reinstalled as directed at no additional cost to the Government.

2. "Conveniently accessible" is defined as being capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as, but not limited to, motors, pumps, belt guards, transformers, piping, ductwork, conduit and raceways.

1.9 EQUIPMENT IDENTIFICATION

- A. Install an identification sign which clearly indicates information required for use and maintenance of equipment.
- B. Nameplates shall be laminated black phenolic resin with a white core with engraved lettering, a minimum of 6 mm (1/4 inch) high. Secure nameplates with screws. Nameplates that are furnished by manufacturer as a standard catalog item, or where other method of identification is herein specified, are exceptions.

1.10 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. The Government's approval shall be obtained for all equipment and material before delivery to the job site. Delivery, storage, or installation of equipment or material which has not had prior approval will not be permitted at the job site.
- C. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings, and other data necessary for the Government to ascertain that the proposed equipment and materials comply with specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify equipment being submitted.
- D. Submittals for individual systems and equipment assemblies which consist of more than one item or component shall be made for the system or assembly as a whole. Partial submittals will not be considered for approval.
 1. Mark the submittals, "SUBMITTED UNDER SECTION ".
 2. Submittals shall be marked to show specification reference including the section and paragraph numbers.
 3. Submit each section separately.
- E. The submittals shall include the following:
 1. Information that confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, pictures, nameplate data and test reports as required.

2. Submittals are required for all equipment anchors and supports. Submittals shall include weights, dimensions, center of gravity, standard connections, manufacturer's recommendations and behavior problems (e.g., vibration, thermal expansion,) associated with equipment or piping so that the proposed installation can be properly reviewed.
3. Elementary and interconnection wiring diagrams for communication and signal systems, control system and equipment assemblies. All terminal points and wiring shall be identified on wiring diagrams.
4. Parts list which shall include those replacement parts recommended by the equipment manufacturer, quantity of parts, current price and availability of each part.

F. Manuals: Submit in accordance with Section 01 00 00, GENERAL REQUIREMENTS.

1. Maintenance and Operation Manuals: Submit as required for systems and equipment specified in the technical sections. Furnish four copies, bound in hardback binders, (manufacturer's standard binders) or an approved equivalent. Furnish one complete manual as specified in the technical section but in no case later than prior to performance of systems or equipment test, and furnish the remaining manuals prior to contract completion.
2. Inscribe the following identification on the cover: the words "MAINTENANCE AND OPERATION MANUAL," the name and location of the system, equipment, building, name of Contractor, and contract number. Include in the manual the names, addresses, and telephone numbers of each subcontractor installing the system or equipment and the local representatives for the system or equipment.
3. Provide a "Table of Contents" and assemble the manual to conform to the table of contents, with tab sheets placed before instructions covering the subject. The instructions shall be legible and easily read, with large sheets of drawings folded in.
4. The manuals shall include:
 - a. Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of the equipment.
 - b. A control sequence describing start-up, operation, and shutdown.

- c. Description of the function of each principal item of equipment.
 - d. Installation and maintenance instructions.
 - e. Safety precautions.
 - f. Diagrams and illustrations.
 - g. Testing methods.
 - h. Performance data.
 - i. Pictorial "exploded" parts list with part numbers. Emphasis shall be placed on the use of special tools and instruments. The list shall indicate sources of supply, recommended spare parts, and name of servicing organization.
 - j. Appendix; list qualified permanent servicing organizations for support of the equipment, including addresses and certified qualifications.
- G. Approvals will be based on complete submission of manuals together with shop drawings.
- H. After approval and prior to installation, furnish the COR with one sample of each of the following:
- 1. A 300 mm (12 inch) length of each type and size of wire and cable along with the tag from the coils of reels from which the samples were taken.
 - 2. Each type of conduit and pathway coupling, bushing and termination fitting.
 - 3. Raceway and pathway hangers, clamps and supports.
 - 4. Duct sealing compound.
- I. In addition to the requirement of SUBMITTALS, the VA reserves the right to request the manufacturer to arrange for a VA representative to see typical active systems in operation, when there has been no prior experience with the manufacturer or the type of equipment being submitted.

1.11 SINGULAR NUMBER

Where any device or part of equipment is referred to in these specifications in the singular number (e.g., "the switch"), this reference shall be deemed to apply to as many such devices as are required to complete the installation as shown on the drawings.

1.12 TRAINING

- A. Training shall be provided in accordance with Article, INSTRUCTIONS, of Section 01 00 00, GENERAL REQUIREMENTS.
- B. Training shall be provided for the particular equipment or system as required in each associated specification.
- C. A training schedule shall be developed and submitted by the contractor and approved by the COR at least 30 days prior to the planned training.

PART 2 - EXECUTION (NOT USED)

PART 3 - EXECUTION (NOT USED)

- - - E N D - - -

SECTION 27 05 26

GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies general grounding and bonding requirements of telecommunication installations for equipment operations.
- B. "Grounding electrode system" refers to all electrodes required by NEC, as well as including made, supplementary, telecommunications system grounding electrodes.
- C. The terms "connect" and "bond" are used interchangeably in this specification and have the same meaning.

1.2 RELATED WORK

- A. Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS:
General electrical requirements and items that are common to more than one section of Division 27.
- B. Section 27 10 00, STRUCTURED CABLING: Low Voltage power and lighting wiring.

1.3 SUBMITTALS

- A. Submit in accordance with Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.
- B. Shop Drawings:
 - 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
 - 2. Include the location of system grounding electrode connections and the routing of aboveground and underground grounding electrode conductors.
- C. Test Reports: Provide certified test reports of ground resistance.
- D. Certifications: Two weeks prior to final inspection, submit four copies of the following to the Contracting Officer's Technical Representative (COR):
 - 1. Certification that the materials and installation is in accordance with the drawings and specifications.
 - 2. Certification, by the Contractor, that the complete installation has been properly installed and tested.

1.4 APPLICABLE PUBLICATIONS

Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.

A. American Society for Testing and Materials (ASTM):

B1-2001..... Standard Specification for Hard-Drawn Copper Wire

B8-2004... Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

B. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

81-1983... IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System

C. National Fire Protection Association (NFPA):

70-2011..... National Electrical Code (NEC)

D. Telecommunications Industry Association, (TIA)

J-STO-607-A-2002Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications

E. Underwriters Laboratories, Inc. (UL):

44-2005 Thermoset-Insulated Wires and Cables

83-2003Thermoplastic-Insulated Wires and Cables

467-2004Grounding and Bonding Equipment

486a-486B-2003Wire Connectors

PART 2 - PRODUCTS

2.1 GROUNDING AND BONDING CONDUCTORS

A. Equipment grounding conductors shall be UL 83 insulated stranded copper, except that sizes 6 mm² (10 AWG) and smaller shall be solid copper. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes 25 mm² (4 AWG) and larger shall be permitted to be identified per NEC.

B. Bonding conductors shall be ASTM B8 bare stranded copper, except that sizes 6 mm² (10 AWG) and smaller shall be ASTM B1 solid bare copper wire.

C. Telecom System Grounding Riser Conductor: Telecommunications Grounding Riser shall be in accordance with J STO-607A. Use a minimum 50mm² (3/0 AWG) insulated stranded copper grounding conductor unless indicated otherwise.

2.2 SPLICES AND TERMINATION COMPONENTS

Components shall meet or exceed UL 467 and be clearly marked with the manufacturer, catalog number, and permitted conductor size(s).

2.3 GROUND CONNECTIONS

A. Above Grade:

1. Bonding Jumpers: compression type connectors, using zinc-plated fasteners and external tooth lock washers.
2. Ground Busbars: Two-hole compression type lugs using tin-plated copper or copper alloy bolts and nuts.
3. Rack and Cabinet Ground Bars: one-hole compression-type lugs using zinc-plated or copper alloy fasteners.

B. Cable Shields: Make ground connections to multipair communications cables with metallic shields using shield bonding connectors with screw stud connection.

2.4 EQUIPMENT RACK AND CABINET GROUND BARS

Provide solid copper ground bars designed for mounting on the framework of open or cabinet- enclosed equipment racks with minimum dimensions of 4 mm thick by 19 mm wide (3/8 inch x 3/4 inch).

2.5 GROUND TERMINAL BLOCKS

At any equipment mounting location (e.g. backboards and hinged cover enclosures) where rack- type ground bars cannot be mounted, provide screw lug-type terminal blocks.

2.6 SPLICE CASE GROUND ACCESSORIES

Splice case grounding and bonding accessories shall be supplied by the splice case manufacturer when available. Otherwise, use 16 mm² (6 AWG) insulated ground wire with shield bonding connectors.

PART 3 - EXECUTION

3.1 GENERAL

- A. Ground in accordance with the NEC, as shown on drawings, and as hereinafter specified.
- B. System Grounding:
 1. Secondary service neutrals: Ground at the supply side of the secondary disconnecting means and at the related transformers.
 2. Separately derived systems (transformers downstream from the service entrance): Ground the secondary neutral.

- C. Equipment Grounding: Metallic structures (including ductwork and building steel), enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits shall be bonded and grounded.

3.2 INACCESSIBLE GROUNDING CONNECTIONS

Make grounding connections, which are buried or otherwise normally inaccessible (except connections for which periodic testing access is required) by exothermic weld.

3.3 CORROSION INHIBITORS

When making ground and ground bonding connections, apply a corrosion inhibitor to all contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between the metals used.

3.4 TELECOMMUNICATIONS SYSTEM

- A. Bond telecommunications system grounding equipment to the electrical grounding electrode system.
- B. Furnish and install all wire and hardware required to properly ground, bond and connect communications raceway, cable tray, metallic cable shields, and equipment to a ground source.
- C. Ground bonding jumpers shall be continuous with no splices. Use the shortest length of bonding jumper possible.
- D. Provide ground paths that are permanent and continuous with a resistance of 1 ohm or less from raceway, cable tray, and equipment connections to the building grounding electrode. The resistance across individual bonding connections shall be 10 milliohms or less.
- E. Above-Grade Grounding Connections: When making bolted or screwed connections to attach bonding jumpers, remove paint to expose the entire contact surface by grinding where necessary; thoroughly clean all connector, plate and other contact surfaces; and apply an appropriate corrosion inhibitor to all surfaces before joining.
- F. Bonding Jumpers:
 - 1. Use insulated ground wire of the size and type shown on the Drawings or use a minimum of 16 mm² (6 AWG) insulated copper wire.
 - 2. Assemble bonding jumpers using insulated ground wire terminated with compression connectors.
 - 3. Use compression connectors of proper size for conductors specified. Use connector manufacturer's compression tool.

G. Bonding Jumper Fasteners:

1. Conduit: Fasten bonding jumpers using screw lugs on grounding bushings or conduit strut clamps, or the clamp pads on push-type conduit fasteners. When screw lug connection to a conduit strut clamp is not possible, fasten the plain end of a bonding jumper wire by slipping the plain end under the conduit strut clamp pad; tighten the clamp screw firmly. Where appropriate, use zinc-plated external tooth lock washers.
2. Wireway and Cable Tray: Fasten bonding jumpers using zinc-plated bolts, external tooth lock washers, and nuts. Install protective cover, e.g., zinc-plated acorn nuts on any bolts extending into wireway or cable tray to prevent cable damage.
3. Ground Plates and Busbars: Fasten bonding jumpers using two-hole compression lugs. Use tin-plated copper or copper alloy bolts, external tooth lock washers, and nuts.
4. Unistrut and Raised Floor Stringers: Fasten bonding jumpers using zinc-plated, self-drill screws and external tooth lock washers.

3.5 COMMUNICATION ROOM GROUNDING

A. Telephone-Type Cable Rack Systems: aluminum pan installed on telephone-type cable rack serves as the primary ground conductor within the communications room. Make ground connections by installing the following bonding jumpers:

1. Install a 16 mm² (6 AWG) bonding between the telecommunications ground busbar and the nearest access to the aluminum pan installed on the cable rack.
2. Use 16 mm² (6 AWG) bonding jumpers across aluminum pan junctions.

B. Self-Supporting and Cabinet-Mounted Equipment Rack Ground Bars:

1. When ground bars are provided at the rear of lineup of bolted together equipment racks, bond the copper ground bars together using solid copper splice plates supplied by the ground bar manufacturer.
2. Bond together nonadjacent ground bars on equipment racks and cabinets with 16 mm² (6 AWG) insulated copper wire bonding jumpers attached at each end with compression-type connectors and mounting bolts.
3. Provide a 16 mm² (6 AWG) bonding jumper between the rack and/or cabinet ground busbar and the aluminum pan of an overhead cable tray or the raised floor stringer as appropriate.

- C. Backboards: Provide a screw lug-type terminal block or drilled and tapped copper strip near the top of backboards used for communications cross-connect systems. Connect backboard ground terminals to the aluminum pan in the telephone-type cable tray using an insulated 16 mm² (16 AWG) bonding jumper.
- D. Other Communication Room Ground Systems: Ground all metallic conduit, wireways, and other metallic equipment located away from equipment racks or cabinets to the cable tray pan or the telecommunications ground busbar, whichever is closer, using insulated 16 mm² (6 AWG) ground wire bonding jumpers.

3.6 COMMUNICATIONS CABLE GROUNDING

- A. Bond all metallic cable sheaths in multipair communications cables together at each splicing and/or terminating location to provide 100 percent metallic sheath continuity throughout the communications distribution system.
 - 1. At terminal points, install cable shield bonding connectors provide a screw stud connection for ground wire. Use a bonding jumper to connect the cable shield connector to an appropriate ground source like the rack or cabinet ground bar.
 - 2. Bond all metallic cable shields together within splice closures using cable shield bonding connectors or the splice case grounding and bonding accessories provided by the splice case manufacturer. When an external ground connection is provided as part of splice closure, connect to an approved ground source and all other metallic components and equipment at that location.

3.7 COMMUNICATIONS CABLE TRAY SYSTEMS:

- A. Bond the metallic structures of one cable tray in each tray run following the same path to provide 100 percent electrical continuity throughout these cable tray systems as follows:
 - 1. Splice plates provided by the cable tray manufacturer can be used for providing a ground bonding connection between cable tray sections when the resistance across a bolted connection is 10 milliohms or less. The Subcontractor shall verify this loss by testing across one splice plate connection in the presence of the Contractor.
 - 2. Install a 16 mm² (6 AWG) bonding jumper across each cable tray splice or junction where splice plates cannot be used.

3. When cable tray terminations to cable rack, install 16 mm² (6 AWG) bonding jumper between cable tray and cable rank pan.

3.8 COMMUNICATIONS RACEWAY GROUNDING

- A. Conduit: Use insulated 16 mm² (6 AWG) bonding jumpers to ground metallic conduit at each end and to bond at all intermediate metallic enclosures.
- B. Wireway: use insulated 16 mm² (6 AWG) bonding jumpers to ground or bond metallic wireway at each end at all intermediate metallic enclosures and across all section junctions.
- C. Cable Tray Systems: Use insulated 16 mm² (6 AWG) bonding jumpers to ground cable tray to column-mounted building ground plates (pads) at each end and approximately every 16 meters (50 feet).

3.9 GROUND RESISTANCE

- A. Grounding system resistance to ground shall not exceed 5 ohms. Make necessary modifications or additions to the grounding electrode system for compliance without additional cost to the Government. Final tests shall assure that this requirement is met.
- B. Resistance of the grounding electrode system shall be measured using a four-terminal fall-of potential method as defined in IEEE 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.
- C. Services at power company interface points shall comply with the power company ground resistance requirements.
- D. Below-grade connections shall be visually inspected by the COR prior to backfilling. The Contractor shall notify the COR 24 hours before the connections are ready for inspection.

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SECTION 27 05 33

RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing, installation, and connection of conduit, fittings, and boxes to form complete, coordinated, raceway systems. Raceways are required for all communications cabling unless shown or specified otherwise.
- B. Definitions: The term conduit, as used in this specification, shall mean any or all of the raceway types specified.

1.2 RELATED WORK

- A. Sealing around penetrations to maintain the integrity of fire rated construction: Section 07 84 00, FIRESTOPPING.
- B. Sealing around conduit penetrations through the building envelope to prevent moisture migration into the building: Section 07 92 00, JOINT SEALANTS.
- C. Identification and painting of conduit and other devices: Section 09 91 00, PAINTING.
- D. General electrical requirements and items that is common to more than one section of Division 27: Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.
- E. Requirements for personnel safety and to provide a low impedance path for possible ground fault currents: Section 27 05 26, GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS.

1.3 SUBMITTALS

In accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, furnish the following:

- A. Shop Drawings:
 - 1. Size and location of panels and pull boxes
 - 2. Layout of required conduit penetrations through structural elements.
 - 3. The specific item proposed and its area of application shall be identified on the catalog cuts.
- B. Certification: Prior to final inspection, deliver to the Contracting Officer's Technical Representative (COR) four copies of the certification that the material is in accordance with the drawings and specifications and has been properly installed.

1.4 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.
- B. National Fire Protection Association (NFPA):
- 70-11 National Electrical Code (NEC)
- C. Underwriters Laboratories, Inc. (UL):
- 1-03 Flexible Metal Conduit
 - 5-01 Surface Metal Raceway and Fittings
 - 6-03 Rigid Metal Conduit
 - 50-03 Enclosures for Electrical Equipment
 - 360-03 Liquid-Tight Flexible Steel Conduit
 - 467-01 Grounding and Bonding Equipment
 - 514A-01 Metallic Outlet Boxes
 - 514B-02 Fittings for Cable and Conduit
 - 514C-05 Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers
 - 651-02 Schedule 40 and 80 Rigid PVC Conduit
 - 651A-03 Type EB and A Rigid PVC Conduit and HDPE Conduit
 - 797-03 Electrical Metallic Tubing
 - 1242-00 Intermediate Metal Conduit
- D. National Electrical Manufacturers Association (NEMA):
- TC-3-04 PVC Fittings for Use with Rigid PVC Conduit and Tubing
 - FB1-03 ... Fittings, Cast Metal Boxes and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable

PART 2 - PRODUCTS

2.1 MATERIAL

- A. Conduit Size: In accordance with the NEC, but not less than 13 mm (3/4 inch) unless otherwise shown.
- B. Conduit:
1. Rigid galvanized steel: Shall Conform to UL 6, ANSI C80.1.
 2. Rigid intermediate steel conduit (IMC): Shall Conform to UL 1242, ANSI C80.6.
 3. Electrical metallic tubing (EMT): Shall Conform to UL 797, ANSI C80.3. Maximum size not to exceed 105 mm (4 inch) and shall be permitted only with cable rated 600 volts or less.
 4. Surface metal raceway: Shall Conform to UL 5.

C. Conduit Fittings:

1. Rigid steel and IMC conduit fittings:

- a. Fittings shall meet the requirements of UL 514B and ANSI/ NEMA FB1.
- b. Standard threaded couplings, locknuts, bushings, and elbows:
Only steel or malleable iron materials are acceptable.
Integral retractable type IMC couplings are also acceptable.
- c. Locknuts: Bonding type with sharp edges for digging into the metal wall of an enclosure.
- d. Bushings: Metallic insulating type, consisting of an insulating insert molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted.
- e. Erickson (union-type) and set screw type couplings: Approved for use in concrete are permitted for use to complete a conduit run where conduit is installed in concrete. Use set screws of case hardened steel with hex head and cup point to firmly seat in conduit wall for positive ground. Tightening of set screws with pliers is prohibited.
- f. Sealing fittings: Threaded cast iron type. Use continuous drain type sealing fittings to prevent passage of water vapor. In concealed work, install fittings in flush steel boxes with blank cover plates having the same finishes as that of other electrical plates in the room.

2. Electrical metallic tubing fittings:

- a. Fittings shall meet the requirements of UL 514B and ANSI/ NEMA FB1.
- b. Only steel or malleable iron materials are acceptable.
- c. Couplings and connectors: Concrete tight and rain tight, with connectors having insulated throats. Use gland and ring compression type couplings and connectors for conduit sizes 50 mm (2 inches) and smaller. Use set screw type couplings with four set screws each for conduit sizes over 50 mm (2 inches). Use set screws of case-hardened steel with hex head and cup point to firmly seat in wall of conduit for positive grounding.
- d. Indent type connectors or couplings are prohibited.

- e. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are prohibited.
5. Expansion and deflection couplings:
- a. Conform to UL 467 and UL 514B.
 - b. Accommodate, 19 mm (0.75 inch) deflection, expansion, or contraction in any direction, and allow 30 degree angular deflections.
 - c. Include internal flexible metal braid sized to guarantee conduit ground continuity and fault currents in accordance with UL 467, and the NEC code tables for ground conductors.
 - d. Jacket: Flexible, corrosion-resistant, watertight, moisture and heat resistant molded rubber material with stainless steel jacket clamps.
- D. Conduit Supports:
- 1. Parts and hardware: Zinc-coat or provide equivalent corrosion protection.
 - 2. Individual Conduit Hangers: Designed for the purpose, having a preassembled closure bolt and nut, and provisions for receiving a hanger rod.
 - 3. Multiple conduit (trapeze) hangers: Not less than 38 mm by 38 mm (1-1/2 by 1-1/2 inch), 12 gage steel, cold formed, lipped channels; with not less than 9 mm (3/8 inch) diameter steel hanger rods.
 - 4. Solid Masonry and Concrete Anchors: Self-drilling expansion shields, or machine bolt expansion.
- E. Outlet, Junction, and Pull Boxes:
- 1. UL-50 and UL-514A.
 - 2. Cast metal where required by the NEC or shown, and equipped with rustproof boxes.
 - 3. Sheet metal boxes: Galvanized steel, except where otherwise shown.
 - 4. Flush mounted wall or ceiling boxes shall be installed with raised covers so that front face of raised cover is flush with the wall. Surface mounted wall or ceiling boxes shall be installed with surface style flat or raised covers.
- F. Wireways: Equip with hinged covers, except where removable covers are shown.

PART 3 - EXECUTION

3.1 PENETRATIONS

A. Cutting or Holes:

1. Locate holes in advance where they are proposed in the structural sections such as ribs or beams. Obtain the approval of the COR prior to drilling through structural sections.
2. Cut holes through concrete and masonry in new and existing structures with a diamond core drill or concrete saw. Pneumatic hammer, impact electric, hand or manual hammer type drills are not allowed, except where permitted by the COR as required by limited working space.

B. Fire Stop: Where conduits, wireways, and other communications raceways pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases as specified in Section 07 84 00, FIRESTOPPING, with rock wool fiber or silicone foam sealant only. Completely fill and seal clearances between raceways and openings with the fire stop material.

C. Waterproofing: At floor, exterior wall, and roof conduit penetrations, completely seal clearances around the conduit and make watertight as specified in Section 07 92 00, JOINT SEALANTS.

3.2 INSTALLATION, GENERAL

A. Install conduit as follows:

1. In complete runs before pulling in cables or wires.
2. Flattened, dented, or deformed conduit is not permitted. Remove and replace the damaged conduits with new undamaged material.
3. Assure conduit installation does not encroach into the ceiling height head room, walkways, or doorways.
4. Cut square with a hacksaw, ream, remove burrs, and draw up tight.
5. Mechanically continuous.
6. Independently support conduit at 8'0" on center. Do not use other supports i.e., (suspended ceilings, suspended ceiling supporting members, lighting fixtures, conduits, mechanical piping, or mechanical ducts).
7. Support within 300 mm (1 foot) of changes of direction, and within 300 mm (1 foot) of each enclosure to which connected.

8. Close ends of empty conduit with plugs or caps at the rough-in stage to prevent entry of debris, until wires are pulled in.
9. Conduit installations under fume and vent hoods are prohibited.
10. Secure conduits to cabinets, junction boxes, pull boxes and outlet boxes with bonding type locknuts. For rigid and IMC conduit installations, provide a locknut on the inside of the enclosure, made up wrench tight. Do not make conduit connections to junction box covers.
11. Unless otherwise indicated on the drawings or specified herein, all conduits shall be installed concealed within finished walls, floors and ceilings.

B. Conduit Bends:

1. Make bends with standard conduit bending machines.
2. Conduit hickey may be used for slight offsets, and for straightening stubbed out conduits.
3. Bending of conduits with a pipe tee or vise is prohibited.

C. Layout and Homeruns:

1. Deviations: Make only where necessary to avoid interferences and only after drawings showing the proposed deviations have been submitted approved by the COR.

3.3 CONCEALED WORK INSTALLATION

A. Walls, furred walls, or inaccessible ceilings.

1. Conduit for communication conductors shall be EMT.

B. Align and run conduit parallel or perpendicular to the building lines.

C. Tightening set screws with pliers is prohibited.

3.4 EXPOSED WORK INSTALLATION

A. Unless otherwise indicated on the drawings, exposed conduit is only permitted in mechanical and electrical rooms.

B. Conduit for Conductors 600 volts and below:

1. Rigid steel, IMC, or EMT. Different type of conduits mixed indiscriminately in the system is prohibited.

C. Align and run conduit parallel or perpendicular to the building lines.

D. Install horizontal runs close to the ceiling or beams and secure with conduit straps.

E. Support horizontal or vertical runs at not over 2400 mm (eight foot) intervals.

F. Surface metal raceways: Use only where shown.

G. Painting:

1. Paint exposed conduit as specified in Section 09 91 00, PAINTING.

3.5 EXPANSION JOINTS

A. Conduits 75 mm (3 inches) and larger, that are secured to the building structure on opposite sides of a building expansion joint, require expansion and deflection couplings. Install the couplings in accordance with the manufacturer's recommendations.

B. Provide conduits smaller than 75 mm (3 inches) with junction boxes on both sides of the expansion joint. Connect conduits to junction boxes with sufficient slack of flexible conduit to produce 125 mm (5 inch) vertical drop midway between the ends. Flexible conduit shall have a copper green ground bonding jumper installed. In lieu of this flexible conduit, expansion and deflection couplings as specified above for 375 mm (15 inches) and larger conduits are acceptable.

C. Install expansion and deflection couplings where shown.

3.6 CONDUIT SUPPORTS, INSTALLATION

A. Safe working load shall not exceed 1/4 of proof test load of fastening devices.

B. Use pipe straps or individual conduit hangers for supporting individual conduits. Maximum distance between supports is 2.5 m (8 foot) on center.

C. Support multiple conduit runs with trapeze hangers. Use trapeze hangers that are designed to support a load equal to or greater than the sum of the weights of the conduits, wires, hanger itself, and 90 kg (200 pounds). Attach each conduit with U-bolts or other approved fasteners.

D. Support conduit independently of junction boxes, pull boxes, fixtures, suspended ceiling T-bars, angle supports, and similar items.

E. Fasteners and Supports in Solid Masonry and Concrete:

1. New Construction: Use steel or malleable iron concrete inserts set in place prior to placing the concrete.

2. Existing Construction:

- a. Steel expansion anchors not less than 6 mm (1/4 inch) bolt size and not less than 28 mm (1-1/8 inch) embedment.

- b. Power set fasteners not less than 6 mm (1/4 inch) diameter with depth of penetration not less than 75 mm (3 inches).

- c. Use vibration and shock resistant anchors and fasteners for attaching to concrete ceilings.
- F. Hollow Masonry: Toggle bolts are permitted.
- G. Bolts supported only by plaster or gypsum wallboard are not acceptable.
- H. Metal Structures: Use machine screw fasteners or other devices specifically designed and approved for the application.
- I. Attachment by wood plugs, rawl plug, plastic, lead or soft metal anchors, or wood blocking and bolts supported only by plaster is prohibited.
- J. Chain, wire, or perforated strap shall not be used to support or fasten conduit.
- K. Spring steel type supports or fasteners are prohibited for all uses except: Horizontal and vertical supports/fasteners within walls.
- L. Vertical Supports: Vertical conduit runs shall have riser clamps and supports in accordance with the NEC and as shown. Provide supports for cable and wire with fittings that include internal wedges and retaining collars.

3.7 BOX INSTALLATION

- A. Boxes for Concealed Conduits:
 - 1. Flush mounted.
 - 2. Provide raised covers for boxes to suit the wall or ceiling, construction and finish.
- B. In addition to boxes shown, install additional boxes where needed to prevent damage to cables and wires during pulling in operations.
- C. Remove only knockouts as required and plug unused openings. Use threaded plugs for cast metal boxes and snap-in metal covers for sheet metal boxes.
- D. Stencil or install phenolic nameplates on covers of the boxes identified on riser diagrams; for example "SIG-FA JB No. 1".

3.8 COMMUNICATION SYSTEM CONDUIT

- A. Install the communication raceway system as shown on drawings.
- B. Minimum conduit size of 19 mm, 3/4 inch but not less than the size shown on the drawings.
- C. All conduit ends shall be equipped with insulated bushings.
- D. All 100 mm (four inch) conduits within buildings shall include pull boxes after every two 90 degree bends. Size boxes per the NEC.

- E. Terminate conduit runs to/from a backboard in a closet or interstitial space at the top or bottom of the backboard. Conduits shall enter communication closets next to the wall and be flush with the backboard.
- F. Where drilling is necessary for vertical conduits, locate holes so as not to affect structural sections such as ribs or beams.
- G. Conduit runs shall contain no more than four quarter turns (90 degree bends) between pull boxes/backboards. Minimum radius of communication conduit bends shall be as follows (special long radius):

Sizes of Conduit	Radius of Conduit Bends mm, Inches
3/4	15 (6)
1	23 (9)
1-1/4	35 (14)
1-1/2	43 (17)
2	52 (21)
2-1/2	63 (25)
3	77 (31)
3-1/2	90 (36)
4	1125)

- H. Furnish and pull wire in all empty conduits. (Sleeves through floor are exceptions).

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SECTION 27 10 00
STRUCTURED CABLING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing, installation, and connection to the existing structured cabling system to provide a comprehensive telecommunications infrastructure.

1.2 RELATED WORK

- A. Sealing around penetrations to maintain the integrity of time rated construction: Section 07 84 00, FIRESTOPPING.
- B. General electrical requirements that are common to more than one section in Division 27: Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.
- C. Conduits for cables and wiring: Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS.
- D. Requirements for personnel safety and to provide a low impedance path for possible ground fault currents: Section 27 05 26, GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS.

1.3 SUBMITTALS

- A. In accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, furnish the following:
1. Manufacturer's Literature and Data: Showing each cable type and rating.
 2. Certificates: Two weeks prior to final inspection, deliver to the Contracting Officer's Technical Representative (COR) four copies of the certification that the material is in accordance with the drawings and specifications and has been properly installed.

1.4 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are reference in the text by the basic designation only.
- B. American Society of Testing Material (ASTM):
- D2301-04 Standard Specification for Vinyl Chloride Plastic Pressure Sensitive Electrical Insulating Tape
- C. Federal Specifications (Fed. Spec.):
- A-A-59544-00.....Cable and Wire, Electrical (Power, Fixed Installation)

D. National Fire Protection Association (NFPA):

70-11 National Electrical Code (NEC)

E. Underwriters Laboratories, Inc. (UL):

44-02 Thermoset-Insulated Wires and Cables

83-03 Thermoplastic-Insulated Wires and Cables

467-01 Electrical Grounding and Bonding Equipment

486a-01 Wire Connectors and Soldering Lugs for Use with Copper Conductors

486C-02 Splicing Wire Connectors

486D-02 .. Insulated Wire Connector Systems for Underground Use or in Damp or Wet Locations 486E-00 Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors

493-01 .. Thermoplastic-Insulated Underground Feeder and Branch Circuit Cable

514B-02 Fittings for Cable and Conduit

1479-03 Fire Tests of Through-Penetration Fire Stops

PART 2 - PRODUCTS

2.1 CONTROL WIRING

- A. Unless otherwise specified in other sections of these specifications, control wiring shall be as specified for power and lighting wiring, except the minimum size shall be not less than No. 14 AWG.
- B. Control wiring shall be large enough so that the voltage drop under inrush conditions does not adversely affect operation of the controls.

2.2 COMMUNICATION AND SIGNAL WIRING

- A. Shall conform to the recommendations of the manufacturers of the communication and signal systems; however, not less than what is shown.
- B. Wiring shown is for typical systems. Provide wiring as required for the systems being furnished.
- C. Multi-conductor cables shall have the conductors color coded.

2.3 WIRE LUBRICATING COMPOUND

- A. Suitable for the wire insulation and conduit it is used with, and shall not harden or become adhesive.
- B. Shall not be used on wire for isolated type electrical power systems.

2.4 FIREPROOFING TAPE

- A. The tape shall consist of a flexible, conformable fabric of organic composition coated one side with flame-retardant elastomer.

- B. The tape shall be self-extinguishing and shall not support combustion. It shall be arc-proof and fireproof.
- C. The tape shall not deteriorate when subjected to water, gases, salt water, sewage, or fungus and be resistant to sunlight and ultraviolet light.
- D. The finished application shall withstand a 200-ampere arc for not less than 30 seconds.
- E. Securing tape: Glass cloth electrical tape not less than 0.18 mm (7 mils) thick, and 19 mm (3/4 inch) wide.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Install all wiring in raceway systems.
- B. Wire Pulling:
 - 1. Provide installation equipment that will prevent the cutting or abrasion of insulation during pulling of cables.
 - 2. Use ropes made of nonmetallic material for pulling feeders.
 - 3. Attach pulling lines for feeders by means of either woven basket grips or pulling eyes attached directly to the conductors, as approved by the COR.
 - 4. Pull in multiple cables together in a single conduit.

3.2 CONTROL, COMMUNICATION AND SIGNAL WIRING INSTALLATION

- A. Unless otherwise specified in other sections install wiring and connect to equipment/devices to perform the required functions as shown and specified.
- B. Except where otherwise required, install a separate power supply circuit for each system so that malfunctions in any system will not affect other systems.
- C. Where separate power supply circuits are not shown, connect the systems to the nearest panel boards of suitable voltages, which are intended to supply such systems and have suitable spare circuit breakers or space for installation.
- D. Install a red warning indicator on the handle of the branch circuit breaker for the power supply circuit for each system to prevent accidental de-energizing of the systems.
- E. System voltages shall be 120 volts or lower where shown on the drawings or as required by the NEC.

3.3 CONTROL, COMMUNICATION AND SIGNAL SYSTEM IDENTIFICATION

- A. Install a permanent wire marker on each wire at each termination.
- B. Identifying numbers and letters on the wire markers shall correspond to those on the wiring diagrams used for installing the systems.
- C. Wire markers shall retain their markings after cleaning.
- D. In each manhole and hand hole, install embossed brass tags to identify the system served and function.

3.4 EXISTING WIRING

Unless specifically indicated on the plans, existing wiring shall not be reused for the new installation. Only wiring that conforms to the specifications and applicable codes may be reused. If existing wiring does not meet these requirements, existing wiring may not be reused and new wires shall be installed.

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SECTION 27 11 00

COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section specifies the furnishing, installing of raceway, boxes and point of use voice and data devices as an extension of an existing Voice and Digital Cable Distribution System (here-in-after referred to as "the System") to the project-related work areas in the VA Building B-1W Ann Arbor here-in-after referred to as "the Facility". The System shall additionally include: telecommunications outlets (TCO) and copper distribution cables. The System shall be extended free of installation, and functional defects.
- B. The term "provide", as used herein, shall be defined as: furnished, installed, certified, and tested, by the Contractor.
- C. The Voice and Digital and Analog Telecommunication Distribution Cable Equipment and System provides the media which voice and data information travels over and connects to the Telephone System which is defined as an Emergency Critical Care Communication System by the National Fire Protection Association (NFPA). Therefore, since the System connects to or extends the telephone system, the System's installation and operation shall adhere to all appropriate National, Government, and/or Local Life Safety and/or Support Codes, which ever are the more stringent for this Facility. At a minimum, the System shall be installed according to NFPA, Section 70, National Electrical Code (NEC), Article 517 and Chapter 7; NFPA, Section 99, Health Care Facilities, Chapter 3-4; NFPA, Section 101, Life Safety Code, Chapters 7, 12, and/or 13; Joint Commission on Accreditation of Health Care Organization (JCAHCO), Manual for Health Care Facilities, all necessary Life Safety and/or Support guidelines; this specification; The VAMC Project Manager (PM) and/or if delegated, COR are the approving authorities for all contractual and mechanical changes to the System. The Contractor is cautioned to obtain in writing, all approvals for system changes relating to the published contract specifications and drawings, from the PM and/or the COR before proceeding with the change.
- D. System Performance:
1. Telecommunications Outlet (TCO):
 - a. Voice:
 - 1) Isolation (outlet-outlet): 24 dB.

- 2) Impedance: 600 Ohms, balanced (BAL).
 - 3) Signal Level: 0 deciBel per mili-Volt (dBmV) + 0.1 dBmV.
 - 4) System speed: 100 mBps, minimum.
 - 5) System data error: 10 to the -6 Bps, minimum.
- b. Data:
- 1) Isolation (outlet-outlet): 24 dB.
 - 2) Impedance: 600 Ohms, BAL.
 - 3) Signal Level: 0 dBmV + 0.1 dBmV.
 - 4) System speed: 120 mBps, minimum.
 - 5) System data error: 10 to the -8 Bps, minimum.

1.2 RELATED WORK

- A. Specification Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Specification Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.
- C. Specification Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS.
- D. Specification Section 27 10 00, STRUCTURED CABLING.
- E. Specification Section 26 27 26, WIRING DEVICES.
- F. Specification Section 27 05 26, GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS.
- G. Specification Section 26 41 00, FACILITY LIGHTNING PROTECTION.

1.3 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in text by basic designation only. Except for a specific date given the issue in effect (including amendments, addenda, revisions, supplements, and errata) on the date the system's submittal is technically approved by VA, shall be enforced.

- B. National Fire Protection Association (NFPA):

70	NATIONAL ELECTRICAL CODE (NEC)
75	Protection of Electronic Computer/Data Processing
77	Recommended Practice on Static Electricity
	Standard for Health Care Facilities
101	Life Safety Code
1221	Emergency Services Communication Systems

C. Underwriters Laboratories, Inc. (UL):

65	Wired Cabinets
96	Lightning Protection
96a	INSTALLATION REQUIREMENTS FOR LIGHTNING PROTECTION SYSTEMS
467	Grounding and Bonding
497/497A/497B	PROTECTORS FOR PAIRED CONDUCTORS/ COMMUNICATIONS CIRCUITS/DATA COMMUNICATIONS AND FIRE ALARM CIRCUITS
884	Underfloor Raceways and

D. ANSI/EIA/TIA Publications:

568B	Commercial Building Telecommunications Wiring
569B	Commercial Building Standard for Pathways and Spaces
606a	ADMINISTRATION STANDARD FOR THE TELECOMMUNICATIONS INFRASTRUCTURE OF COMMERCIAL BUILDINGS
607A	Grounding and Bonding Requirements for Telecommunications in Commercial
758	Grounding and Bonding Requirements for Telecommunications in Commercial

E. Lucent Technologies: Document 900-200-318 "Outside Plant Engineering Handbook".

F. International Telecommunication Union - Telecommunication Standardization Sector (ITU-T).

G. Federal Information Processing Standards (FIPS) Publications.

H. Federal Communications Commission (FCC) Publications: Standards for telephone equipment and systems.

I. United States Air Force: Technical Order 33K-1-100 Test Measurement and Diagnostic Equipment (TMDE) Interval Reference Guide.

J. Joint Commission on Accreditation of Health Care Organization (JCAHO): Comprehensive Accreditation Manual for Hospitals.

K. National and/or Government Life Safety Code(s): The more stringent of each listed code.

1.4 QUALITY ASSURANCE

- A. Documents: The submittal shall be separated into sections for each subsystem and shall contain the following:
 - 1. Title page to include:
 - a. VA Medical Center.
 - b. Contractor's name, address, and telephone (including FAX) numbers.
 - c. Date of Submittal.
 - d. VA Project No.
- B. Samples: A sample of each of the following items shall be furnished to the COR for approval prior to installation.
 - 1. TCO Wall Outlet Box 4" x 4"x 2.5" with:
 - a. One each telephone (or voice) rj45 jack installed.
 - b. Two each multi pin data rj45 jacks installed.
 - c. Cover Plate installed.
 - d. RF (F) jack(s) installed where required.
 - 2. Data connection device with RJ45 connectors installed.
 - 3. Telephone RJ45 connectors and cable terminal equipment installed.
 - 4. 610 mm (2 ft.) section of each copper cable to be used with cable sweep tags as specified in paragraph 2.4.H and connectors installed.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Conduit and Signal Ducts:
 - 1. Conduit:
 - a. The Contractor shall employ the latest installation practices and materials. The Contractor shall provide conduit, junction boxes, connectors, sleeves, weatherheads, pitch pockets, and associated sealing materials not specifically identified in this document as GFE. Conduit penetrations of walls, ceilings, floors, interstitial space, fire barriers, etc., shall be sleeved and sealed. The minimum conduit size shall be 25 mm (1 in.).

- b. All cables shall be installed in separate conduit and/or signal ducts (exception from the separate conduit requirement to allow telephone cables to be installed in partitioned cable tray with data cables may be granted in writing by the COR if requested.) Conduits shall be provided in accordance with Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS, and NEC Articles 517 for Critical Care and 800 for Communications systems, at a minimum.
 - c. When metal, plastic covered, etc., flexible cable protective armor or systems are specifically authorized to be provided for use in the System, their installation guidelines and standards shall be as specified herein, Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS, and the NEC.
 - d. When "innerduct" flexible cable protective systems is specifically authorized to be provided for use in the System, it's installation guidelines and standards shall be as the specified herein, Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS, and the NEC.
 - e. Conduit (including GFE) fill shall not exceed 40%. Each conduit end shall be equipped with a protective insulator or sleeve to cover the conduit end, connection nut or clamp, to protect the wire or cable during installation and remaining in the conduit. Electrical power conduit shall be installed in accordance with the NEC. AC power conduit shall be run separate from signal conduit.
 - f. When metal, plastic covered, etc., flexible cable protective armor or systems are specifically authorized to be provided for use in the System, their installation guidelines and standards shall be as specified herein, Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS, and the NEC.
 - g. Ensure that PA System (as identified by NEC Section 517) is completely separated and protected from all other systems.
2. Signal Duct, Cable Duct, or Cable Tray:
- a. The Contractor shall use existing signal duct, cable duct, and/or cable tray, when identified and approved by the Contracting Officer's Technical Representative (COR).

B. Connectors: Circuits, transmission lines, and signal extensions shall have continuity, correct connection and polarity. A uniform polarity shall be maintained between all points in the system.

1. Wires:

- a. Wire ends shall be neatly formed and where insulation has been cut, heat shrink tubing shall be employed to secure the insulation on each wire. Tape of any type is not acceptable.
- b. Audio spade lugs shall be installed on each wire (including spare or unused) end and connect to screw terminals of appropriate size barrier strips. AC barrier strips shall be provided with a protective cover to prevent accidental contact with wires carrying live AC current. Punch blocks are approved for signal, not AC wires. Wire Nut or "Scotch Lock" connectors are not acceptable for signal wire installation.

2. Cables: Each connector shall be designed for the specific size cable being used and installed with the OEM's approved installation tool. Typical system cable connectors include; but, are not limited to: Audio spade lug, punch block, wirewrap, etc.

3. Speaker Line Audio:

- a. Each connector shall be installed according to the cable, transformer or speaker OEM instructions and using the OEM's approved installation tool. The Contractor shall ensure each speaker is properly phased and connected in the same manner throughout the System using two conductor type wires.
- b. One of the conductors shall be color coded to aid in establishing speaker signal polarity. Each speaker line shall be permanently soldered or audio spade lug connected to each appropriate speaker or line matching transformer connection terminal. Speaker line connection to each audio amplifier shall use audio spade lugs, as described herein.

C. AC Power: AC power wiring shall be run separately from signal cable.

D. Grounding:

1. General: The Contractor shall ground all Contractor Installed Equipment and identified Government Furnished Equipment to eliminate all shock hazards and to minimize, to the maximum extent possible, all ground loops, common mode returns, noise pickup, crosstalk, etc. The total ground resistance shall be 0.1 Ohm or less.

- a. The Contractor shall install lightning arrestors and grounding in accordance with the NFPA and this specification.
 - b. Under no conditions shall the AC neutral, either in a power panel or in a receptacle outlet, be used for system control, subcarrier or audio reference ground.
 - c. The use of conduit, signal duct or cable trays as system or electrical ground is not acceptable and will not be permitted. These items may be used only for the dissipation of internally generated static charges (not to be confused with externally generated lightning) that may applied or generated outside the mechanical and/or physical confines of the System to earth ground. The discovery of improper system grounding shall be grounds to declare the System unacceptable and the termination of all system acceptance testing.
2. Cable Shields: Cable shields shall be bonded to the cabinet ground buss with #12 AWG minimum stranded copper wire at only one end of the cable run. Cable shields shall be insulated from each other, faceplates, equipment racks, consoles, enclosures or cabinets; except, at the system common ground point. Coaxial and audio cables, shall have one ground connection at the source; in all cases, cable shield ground connections shall be kept to a minimum.

- - - E N D - - -

SECTION 27 15 00

COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section specifies the furnishing, installing and warranty of an extension to an existing Voice and Digital Cable Distribution System (here-in-after referred to as "*the System*"). to be installed in the VAMC Building B-1W hereinafter referred to as "*the Facility*". The System shall include, but not be limited to: voice and data distribution devices and associated hardware. The System shall additionally include: telecommunications outlets (TCO); copper distribution cables, connectors, "patch" cables, and/or "break out" devices.
- B. The System shall be delivered free of manufacturing, installation, and functional defects. It shall be installed for ease of operation, maintenance, and testing.
- C. The term "provide", as used herein, shall be defined as: furnished, installed, certified, and tested, by the Contractor.
- D. The Voice and Digital and Analog Telecommunication Distribution Cable System provides the media which voice and data information travels over and connects to the Telephone System which is defined as an Emergency Critical Care Communication System by the National Fire Protection Association (NFPA). Therefore, since the System connects to or extends the telephone system, the System's installation and operation shall adhere to all appropriate National, Government, and/or Local Life Safety and/or Support Codes, which ever are the more stringent for this Facility. At a minimum , the System shall be installed according to NFPA, Section 70, National Electrical Code (NEC), Article 517 and Chapter 7; NFPA, Section 99, Health Care Facilities, Chapter 3-4; NFPA, Section 101, Life Safety Code, Chapters 7, 12, and/or 13; Joint Commission on Accreditation of Health Care Organization (JCAHCO), Manual for Health Care Facilities, all necessary Life Safety and/or Support guidelines; this specification; and the original equipment manufacturers (OEM) suggested installation design, recommendations, and instructions. The VAMC Project Manager (PM) and/or if delegated, COR are the approving authorities for all contractual and mechanical changes to the System.

The Contractor is cautioned to obtain in writing, all approvals for system changes relating to the published contract specifications and drawings, from the PM and/or the COR before proceeding with the change.

E. System Performance:

1. At a minimum, the System shall be able to support the following voice and data operations for Category 6a Certified Telecommunication Service
2. At a minimum the System shall support the following operating parameters:

a.b. Telecommunications Outlet (TCO):

1) Voice:

- a) Isolation (outlet-outlet): 24 dB.
- b) Impedance: 600 Ohms, balanced (BAL).
- c) Signal Level: 0 deciBel per mili-Volt (dBmV) + 0.1 dBmV.
- d) System speed: 100 mBps, minimum.
- e) System data error: 10 to the -6 Bps, minimum.

2) Data:

- a) Isolation (outlet-outlet): 24 dB.
- b) Impedance: 600 Ohms, BAL.
- c) Signal Level: 0 dBmV + 0.1 dBmV.
- d) System speed: 120 mBps, minimum.
- e) System data error: 10 to the -8 Bps, minimum.

1.2 RELATED WORK

- A. Specification Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Specification Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.
- C. Specification Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS.
- D. Specification Section 27 1500.16, VOICE STRUCTURED CABLING.
- E. Specification Section 27 1500.19, DATA STRUCTURED CABLING.
- F. Specification Section 27 05 26, GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS.

1.3 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in text by basic designation only. Except for a specific date given the issue in effect (including amendments, addenda, revisions, supplements, and

errata) on the date the system's submittal is technically approved by VAMC, shall be enforced.

B. National Fire Protection Association (NFPA):

70	NATIONAL ELECTRICAL CODE (NEC)
75	Protection of Electronic Computer/Data Processing
77	Recommended Practice on Static Electricity
	Standard for Health Care Facilities
101	Life Safety Code
1221	Emergency Services Communication Systems

C. Underwriters Laboratories, Inc. (UL):

65	Wired Cabinets
	FOR LIGHTNING
467	Grounding and Bonding

D. ANSI/EIA/TIA Publications:

568B	Commercial Building Telecommunications Wiring
569B	Commercial Building Standard for Telecommunications
606a	ADMINISTRATION STANDARD FOR THE TELECOMMUNICATIONS INFRASTRUCTURE OF COMMERCIAL BUILDINGS
607A	Grounding and Bonding Requirements for Telecommunications in Commercial Buildings
758	Grounding and Bonding Requirements for Telecommunications in Commercial Buildings

E. Federal Information Processing Standards (FIPS) Publications.

F. Federal Communications Commission (FCC) Publications: Standards for telephone equipment and systems.

G. United States Air Force: Technical Order 33K-1-100 Test Measurement and Diagnostic Equipment (TMDE) Interval Reference Guide.

H. Joint Commission on Accreditation of Health Care Organization (JCAHO):
Comprehensive Accreditation Manual for Hospitals.

I. National and/or Government Life Safety Code(s): The more
stringent of each listed code.

1.4 QUALITY ASSURANCE

A. The Contractor's Telecommunications Technicians assigned to the System
shall be fully trained, qualified, and certified on the installation
of the System.

1.5 SUBMITTALS

A. Provide submittals in accordance with Specification Section 01 33
23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES. The COR shall retain one
copy for review and approval.

1. If the submittal is approved the COR shall retain one copy for
Official Records and return three (3) copies to the Contractor.

2. If the submittal is disapproved, three (3) copies will be returned
to the Contractor with a written explanation attached that indicates
the areas the submittal deviated from the System specifications. The
COR shall retain one copy for Official Records.

B. Documents: The submittal shall be separated into sections for each
subsystem and shall contain the following:

1. Title page to include:

a. VA Medical Center.

b. Contractor's name, address, and telephone (including FAX)
numbers.

c. Date of Submittal.

d. VA Project No.

2. List containing a minimum of three locations of installations of
similar size and complexity as identified herein. These locations
shall contain the following:

a. Installation Location and Name.

b. Owners or User's name, address, and telephone (including FAX)
numbers.

c. Date of Project Start and Date of Final Acceptance by Owner.

d. System Project Number.

e. Brief (three paragraphs minimum) description of each system's
function, operation, and installation.

3. Narrative Description of the system.

4. A List of the equipment to be furnished. The quantity, make, and model number of each item is required. The following is the minimum equipment required by the system:

QUANTITY	UNIT
As required	Cross Connection (CCS) Systems
As required	Wire Management System/Equipment
As required	Telecommunications Outlets (TCO)
As Required	Distribution Cables
As required	TCO Connection Cables
As required	System Connectors
As required	Terminators
As required	Distribution Frames

5. Equipment technical literature detailing the electrical and technical characteristics of each item of equipment to be furnished.
6. List of test equipment as per paragraph 1 .5.D. below.
7. Letter certifying that the Contractor understands the requirements of the SAMPLES Paragraph 1.5.E.
8. Letter certifying that the Contractor understands the requirements of Section 3.2 concerning acceptance tests.

C. Test Equipment List:

1. The Contractor is responsible for furnishing all test equipment required to test the system in accordance with the parameters specified. Unless otherwise stated, the test equipment shall not be considered part of the system. The Contractor shall furnish test equipment of accuracy better than the parameters to be tested.
2. The test equipment furnished by the Contractor shall have a calibration tag of an acceptable calibration service dated not more than 12 months prior to the test. As part of the submittal, a test equipment list shall be furnished that includes the make and model number of the following type of equipment as a minimum:

- a. Spectrum Analyzer.
 - b. Signal Level Meter.
 - c. Volt-Ohm Meter.
 - d. Time Domain Reflectometer (TDR) with strip chart recorder (Data and Optical Measuring).
 - e. Bit Error Test Set (BERT).
- D. Samples: A sample of each of the following items shall be furnished to the COR for approval prior to installation.
- 1. TCO Wall Outlet Box 4" x 4"x 2.5" with:
 - a. One each telephone (or voice) rj45 jack installed.
 - b. Two each multi-pin data rj45 jacks installed.
 - c. Cover Plate installed.
 - 2. Data CCS patch panel, punch block or connection device with RJ45 connectors installed.
 - 3. 610 mm (2 ft.) section of each copper cable to be used with cable sweep tags as specified in paragraph 2.4.H and connectors installed.
 - 4. 610 mm (2 ft.) section of each fiber optic cable to be used with cable sweep tags as specified in paragraph 2.4.H and connectors installed.
- E. Certifications:

UTP (and/or STP) Requirements/Column Explanation:

Column	Explanation
FROM BUILDING	Identifies the building by number, title, or location, and main signal closet or intermediate signal closet cabling is
BUILDING	Identifies the building by number, title, or location cabling is to be provided in
TO BUILDING IMC	Identifies building main terminal signal closet, by room number or location, to which cabling is provided too in and
FLOOR	Identifies the floor by number (i.e. 1st, 2nd, etc.) cabling and TCOs are to be
TC ROOM NUMBER	Identifies the floor signal closet room, by room number, which cabling shall be
ROOM NUMBER	Identifies the room, by number, from which cabling and TCOs shall be provided
NUMBER OF CABLE PAIR	Identifies the number of cable pair required to be provided on each floor designated OR the number of cable pair (VA
NUMBER OF STRANDS USED/SPARE	Identifies the number of strands provided in each run

b. Fiber Optic Cabling Requirements/Column Explanation:

Column	Explanation
FROM BUILDING	Identifies the building by number, title, or location, and main signal closet or intermediate signal closet cabling is
TO BUILDING IMC	Identifies building, by number, title, or location, to which cabling is provided
FLOOR	Identifies the floor by number (i.e. 1st,
TC ROOM NUMBER	Identifies the room, by number, from which cabling shall be installed
NUMBER OF STRANDS	Identifies the number of strands in each run of fiber optic cable
INSTALLED METHOD	Identifies the method of installation in accordance with as designated herein
NOTES	Identifies a note number for a special
BUILDING MTC	Identifies the building by number or title

5. Telecommunication Outlets: The Contractor shall clearly and fully indicate this category for each outlet location and compare the total count to the locations identified above as a part of the technical submittal. Additionally, the Contractor shall indicate the total number of spares.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS

A. System Requirements:

1. Cable Systems - Twisted Pair and Fiber optic:

a. General:

- 1) The Contractor shall be responsible for providing a new system conforming to current and accepted telephone and digital industrial/commercial cable distribution standards. The distribution cable installation shall be fully coordinated with the Facility, the PM, the COR and the Contractor prior to the start of installation.
- 2) The Contractor is responsible for complete knowledge of the space and cable pathways (i.e. equipment rooms, TCs, conduits, wireways, etc.) of the Facility. The Contractor shall at a minimum design and install the System using the Pathway Design Handbook H-088C3, TIA/EIA Telecommunications Building

Wiring Standards, and Facility Chief of Information Resource Management's (IRM) instructions, as approved in writing by the PM and/or Contracting Officer's Technical Representative (COR).

- 3) The System cables shall be fully protected by cable duct, trays, wireways, conduit (rigid, thin wall, or flex), and when specifically approved, flexible inner-duct. It is the responsibility of the Contractor to confirm all contract drawings and the Facility's physical layout to determine the necessary cable protective devices to be provided. If flexible inner-duct is used, it shall be installed in the same manner as conduit.
- 4) Cable provided in the system (i.e., inside plant, and station cabling) shall conform to accepted industry and OEM standards with regards to size, color code, and insulation. The pair twists of any pair shall not be exactly the same as any other pair within any unit or sub-unit of cables that are bundled in twenty-five (25) pairs or less. The absence of specifications regarding details shall imply that best general industry practices shall prevail and that first quality material and workmanship shall be provided. Certification Standards, (i.e., EIA, CCITT, FIPPS, and NFPA) shall prevail.
- 5) All areas of this Facility may be considered "plenum". All wire and cable used in support of the installation in those areas (if any) shall be in compliance with national and local codes pertaining to plenum environments. It is the responsibility of the Contractor to review the VA's cable and wire requirements with VA Facility Engineering, COR or IRM prior to installation to confirm the type of environment present at each location.
- 6) The Contractor shall provide inside plant cables that furnishes the number of cable pairs required in accordance with the System requirements described herein. The Contractor shall fully coordinate and obtain approval of the design with the OEM, COR and the IRM prior to installation.
- 7) All metallic cable sheaths, etc. shall be grounded by the Contractor (i.e.: risers, underground, station wiring, etc.) as described herein.

- 8) If temporary cable and wire pairs are used, they shall be installed so as to not present a pedestrian safety hazard and the Contractor shall be responsible for all work associated with the temporary installation and for their removal when no longer necessary. Temporary cable installations are not required to meet Industry Standards; but, must be reviewed and approved by the COR and the IRM prior to installation.
- 9) Conductors shall be cabled to provide protection against induction in voice and data circuits. Crosstalk attenuation within the System shall be in excess of -80 dB throughout the frequency ranges specified.
- 10) Measures shall be employed by the Contractor to minimize the radiation of RF noise generated by the System equipment so as not to interfere with audio, video, data, computer main distribution frame (MDF), telephone customer service unit (CSU), and electronic private branch exchange (EPBX) equipment the System may service.
- 11) The System's cables shall be labeled on each end and been fully tested and certified in writing by the Contractor to the COR before proof of performance testing can be conducted. The as-installed drawings shall identify each cable as labeled, used cable, and bad cable pairs. Minimum test requirements are for impedance compliance, inductance, capacitance, signal level compliance, opens, shorts, cross talk, noise, and distortion, and split pairs on all cables in the frequency ranges specified. The tests required for data cable must be made to guarantee the operation of this cable at not less than 10 mega (m) Hertz (Hz) full bandwidth, fully channel loaded and a Bit Error Rate of a minimum of 10^{-6} at the maximum rate of speed. All cable installation and test records shall be made available at acceptance testing by the COR or Contractor and thereafter maintained in the Facility's Telephone Switch Room. All changes (used pair, failed pair, etc.) shall be posted in these records as the change occurs.

- 12) The Contractor shall provide proper test equipment to guarantee that cable pairs meet each OEM's standard transmission requirements, and guarantee the cable will carry data transmissions at the required speeds, frequencies, and fully loaded bandwidth.
- b. Telecommunications Closets (TC): In TC's that are served with both a UTP backbone cable and a fiber optic backbone cable, the UTP cable shall be terminated on separate RJ-45, 8-pin connectors with 110A or equivalent type punch down blocks located on the back or front of a 48-port modular patch panel dedicated to data applications. Only the UTP backbone cable pairs, identified as being connected to the fiber optic backbone, shall be extended to the fiber optic interface device. All connecting cables required to extend these cables (i.e. patch cords, twenty-five pair connectors, etc.), to the fiber optic interface device, in the TC's shall also be provided by the Contractor to insure a complete and operational fiber optic distribution system:
- 1) In TC's, which are only served by a UTP backbone cable, the cable shall be terminated on separate modular connecting devices (110A or equivalent) that are dedicated to data applications. In order to provide full service to all data cable pairs as identified in each TC/cabinet including spare capacity noted herein, the size of all vertical (riser) cables and/or outside cables serving these TC's shall be increased as required.
- c. Backbone and Trunk Cables:
- 1) The Contractor shall identify, in the technical submittal, the voice and data connecting arrangements required by the LEC for interconnection of the System to the commercial telephone and FTS networks. The Contractor shall provide all required voice and data connecting arrangements.
 - 2) All submitted equipment shall meet or exceed standards, rules, and regulations of the Federal Communications Commission (FCC) and shall be capable of operating without outboard or "extra" devices. The Contractor shall identify the FCC registration number of the System equipment, EPBX, and proposed CSU (if known) in the technical submittal.

d. Horizontal and Station Cable:

- 1) A Four (4) UTP 24 AWG station wiring cable shall be installed from the top TCO jack to the TC and shall be of a type designed to support Category 6a communications (500 mega-Hertz [MHz] or above). Pinning/Punch down shall conform to EIA/TIA 568 Standard "T568A" and NFPA.
- 2) A Four (4) UTP 24 AWG (in thermoplastic jacket unless otherwise specified by RE) station wiring cable shall be installed from each of the two (2) bottom TCO RJ-45 jacks (shall conform to EIA/TIA 568 Standard "T568A" and NFPA) to the TC and shall be of a type designed to support Category 6a communications (500 MHz or above).

e. Telecommunication Outlets (TCO), Wall Box: All boxes are dual gang (4"x4"x2.5"). Jacks: All TCO's shall have a minimum of three (3) RJ-45 type jacks. The top jack shall be an eight pin RJ-45/11 compatible jack, labeled, and designated for telephone applications only. The bottom two jacks shall be eight pin RJ-45 type unkeyed (sometimes called center keyed) jacks, labeled, and designated for data.

1. Voice cross connect subsystems:

2. For ease of maintenance purposes, all terminations shall be accessible without the need for disassembly of the IDC wafer. IDC wafers shall be removable from their mounts to facilitate testing on either side of the connector. Designation strips or labels shall be removable to allow for inspection of the terminations. The maximum number of terminations on a wall or on a rack frame or panel shall comply with the OEM recommendations and guidelines, and as described herein. A cable management system shall be provided as a part of the IDC.
- 4) IDC connectors shall be capable of supporting cable re-terminations without damaging the connector and shall support a minimum of 200 (telephone equipment standard compliant) IDC insertions or withdrawals on either side of the connector panel.

- 5) A non-impact termination method using a full-cycle terminating tool having both a tactile and an audible feedback to indicate proper termination is required. For personnel safety and ease of use in day to day administration, high impact installation tools shall not be used.
 - 6) The splitting of pairs within cables between different jacks or connections shall not be allowed. In the case of ISDN and/or ATM and /or Frame Relay applications, terminating resistors shall be provided externally to the patch panel connector or jack.
 - 7) UTP or STP cross connecting wires shall be provided for each "pair" of connection terminals plus an additional 50% spare.
- e. Data Cross-Connection Subsystems:
- 1) Each panel shall conform to EIA dimensions and be suitable for mounting in standard equipment racks, have the RJ45 jacks aligned in two horizontal rows (up to a maximum of 48 jacks per panel), and shall not exceed the OEM's recommendations. Each RJ45 jack shall be of modular design and capable of accepting and functioning with other modular (i.e., RJ11) plugs without damaging the jack. It is not necessary to provide a jack for unused positions that are not part of the 50% expansion requirement.
 - a) All data system inputs from the server(s), data LAN, bridge, or interface distribution systems shall appear on the "top" row of jacks of the appropriate patch panel.
 - b) The splitting of pairs within cables between different jacks shall not be allowed. In the case of ISDN and/or ATM and/or Frame Relay applications, terminating resistors shall be provided externally to the patch panel connector or jack.
 - 2) A patch cord shall be provided for each system "pair" of connection jacks. Each patch cord shall have modular RJ45 connectors provided on each end to match the panel's modular RJ45 female jack's being provided.

- 3) The Contractor shall not "cross-connect" the VCCS or HCCS cabling systems even though appropriate patch cords are provided for each "patch", "punch", or "breakout" panel. Also, the Contractor shall not provide active interface or distribution electronic equipment as a part of the System.
- f. Horizontal (or Station) Cabling (HC): The HC distribution cabling systems connects the distribution field of the voice and data HCCS, in a "Star" Topology, to each TCO or connector and as shown on the drawings.
 - 1) Horizontal cables shall consist of insulated, UTP conductors that are rated for Category 6a telecommunications service for voice and data systems.
 - 2) The number of UTP distribution pairs dedicated to each floor from the HC shall be sufficient to accommodate all the horizontal voice and data circuits served by the distribution cable to each TCO.
 - a) A minimum of four pairs for voice shall be connected to the "right" side of the IDC (or 110A block) that the VCCS "input" connections appear in the RTC.
 - b) A minimum of two separate sets of four pairs each for data shall be connected to the "bottom" row of RJ45 jacks that the VCCS "input" connections appear in the RTC.
 - 3) The horizontal cable length to the farthest system outlet shall be limited to a maximum of 90M (or 295 ft). These maximum lengths must be derated, adjusted and reduced to include cross-connection and distribution system losses. Additional TC(s) shall be provided on large floor areas of buildings to limit the horizontal distribution to a maximum of 90M (or 295 ft).
 - 4) The splitting of pairs within a cable between different jacks shall not be permitted.
 - 5) The installation of the HC shall conform to appropriate OEM recommendations and standards outlined herein. This requirement will insure adequate protection for Electro-Magnetic Interference (EM I) sources.
 - 6) A system design where "looping" the HC distribution cables from room to room shall not be permitted.
 - 7) Horizontal cabling shall be provided with a 20' coil at each end, labeled and managed for connection by VAMC.

- 8) Where existing outlets are being re-used or re-located, the existing cabling shall be removed from the TCO, labeled for identification and length, coiled above the ceiling during construction, re-pulled to new outlet location and left for final terminations by VAMC. Cable ends at the RTC patch panel or 110A block shall be maintained.
- 9) Where existing outlets are being removed, the existing cabling shall be completely pulled out and removed.
1. System Telecommunication Outlets (TCO): The System shall be capable of receiving the specified telephone (or voice) and data signals acquired from the LEC, FTS contracted carrier and computer system, and shall process and distribute them to the designated TCO's and as shown on the drawings.
 - 1) Each TCO shall consist of three multi-pin modular RJ45 jacks, one designated for telephone and two for data service (some locations may require more). Each TCO with appropriate jacks installed shall be provided by the Contractor in each designated location and as shown on the drawings.
 - 2) The Contractor shall connect each telephone multi-pin modular RJ45 jack to a separate "right side as you look at it" telephone HC distribution system HCCS "punch down" 110A block or approved IDC terminating device in each associated RTC. The modular RJ45 jack shall be able to accept and operate with smaller modular RJ11 plugs while providing proper connection and not damaging the modular jack. The OEM shall warrant all modular RJ45/11 jacks in such a manner to be usable for modular RJ11 plugs.
 - 3) The Contractor shall connect each TCO data multi-pin modular RJ45 jack to a separate lower row jack on the HCCS "patch panel" in each associated RTC. The Contractor is not to "cross-connect" VCCS and HCCS data distribution cables or provides active electronic data distribution equipment as a part of the System.
 - 4) A non-impact termination method, using either a stuffer cap with installation tool or full-cycle terminating tool having both tactile and audible feedback to indicate proper termination shall be used. High impact installation tools shall not be used.

- 5) Each terminated conductor end shall be properly trimmed to assure a minimum clearance of 6.35 mm (0.250 in) clearance between the conductors of adjacent modules.
- 6) The multi-pin RJ45 jack shall be modular in construction that will accept and operate with a modular UTP and STP RJ45 connector and its pin assignments.

B. System Performance:

1. At a minimum, the System shall be able to support the following voice and data operations for

Category 6a Certified Telecommunication Service:

2. At a minimum the System shall support the following operating parameters:
 - a. EPBX connection:
 - 1) System speed: 1.0 gBps per second, minimum.
 - 2) Impedance: 600 Ohms.
 - 3) Cross Modulation: -60 deci-Bel (dB).
 - 4) Hum Modulation: -55 Db.
 - 5) System data error: 10 to the -10 Bps, minimum loss measured at the frame output with reference Zero (0) decibel measured (dBm) at 1,000 Hertz (Hz) applied to the frame input.
 - a) Trunk to station: 1.5 dB, maximum.
 - b) Station to station: 3.0 dB, maximum.
 - c) Internal switch crosstalk: -60 dB when a signal of + 10 decibel measured (dBm), 500-2,500 Hz range is applied to the primary path.
 - d) Idle channel noise: 25 dBm "C" or 3.0 dBm "O" above reference (terminated) ground noise, whichever is greater.
 - e) Traffic Grade of Service for Voice and Data:
 - (1) A minimum grade of service of P-01 with an average traffic load of 7.0 CCS per station per hour and a traffic overload in the data circuits will not interfere with, or degrade, the voice service.
 - (2) Average CCS per voice station: The average CCS capacity per voice station shall be maintained at 7.0 CCS when the EPBX is expanded up to the projected maximum growth as stated herein.
- b. Telecommunications Outlet (TCO):
 - 1) Voice:
 - a) Isolation (outlet-outlet): 24 dB.

- b) Impedance: 600 Ohms, balanced (BAL).
- c) Signal Level: 0 decibel per mili-Volt (dBmV) + 0.1 dBmV.
- d) System speed: 100 mBps, minimum.
- e) System data error: 10 to the -6 Bps, minimum.

2) Data:

- a) Isolation (outlet-outlet): 24 dB.
- b) Impedance: 600 Ohms, BAL.
- c) Signal Level: 0 dBmV + 0.1 dBmV.
- d) System speed: 120 mBps, minimum.
- e) System data error: 10 to the -8 Bps, minimum.

C. General:

1. The Contractor shall provide written verification, in writing to the COR at time of installation, that the type of wire/cable being provided is recommended and approved by the OEM. The Contractor is responsible for providing the proper size and type of cable duct and/or conduit and wiring even though the actual installation may be by another subcontractor.
2. Active electronic component equipment shall consist of solid state components, be rated for continuous duty service, comply with the requirements of FCC standards for telephone equipment, systems, and service.
3. All passive distribution equipment shall meet or exceed -80 dB radiation shielding specifications.
4. All interconnecting multi-pair voice or fiber-optic cables shall be terminated on equipment terminal boards, punch blocks, breakout boxes, splice blocks, and unused equipment ports/taps shall be terminated according to the OEM's instructions for telephone cable systems without adapters. The Contractor shall not leave unused or spare multi-pair voice or fiber-optic cable un-terminated, unconnected, loose or unsecured.
5. Color code all distribution wiring to conform to the Telephone Industry standard, EIA/TIA, and this document, whichever is the more stringent. At a minimum, all equipment, cable duct and/or conduit, enclosures, wiring, terminals, and cables shall be clearly and permanently labeled according to and using the provided record drawings, to facilitate installation and maintenance. Reference Specification Section 27 10 00, STRUCTURED CABLING.

6. Connect the System's primary input AC power to the Facility's Critical Branch of the Emergency AC power distribution system as shown on the plans or if not shown on the plans consult with COR regarding a suitable circuit location prior to bidding.
7. Plug-in connectors shall be provided to connect all equipment, except coaxial cables and interface points. All equipment faceplates utilized in the System shall be stainless steel.

E. Equipment Standards and Testing:

1. The System has been defined herein as connected to systems identified as Critical Care performing Life Support Functions. Therefore, at a minimum, the system shall conform to all aforementioned National and/or Local Life Safety Codes (which ever are the more stringent), NFPA, NEC, this specification, JCAHCO Life Safety Accreditation requirements, and the OEM recommendations, instructions, and guidelines.
2. All supplies and materials shall be listed, labeled or certified by UL or a nationally recognized testing laboratory where such standards have been established for the supplies, materials or equipment. See paragraph minimum requirements Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS, and the guidelines listed in paragraph 2.J.2.
3. The provided active and passive equipment required by the System design and approved technical submittal must conform with each UL standard in effect for the equipment, as of the date of the technical submittal (or the date when the COR approved system equipment necessary to be replaced) was technically reviewed and approved by VAMC. Where a UL standard is in existence for equipment to be used in completion of this contract, the equipment must bear the approved UL seal.
4. Each item of electronic equipment to be provided under this contract must bear the approved UL seal or the seal of the testing laboratory that warrants the equipment has been tested in accordance with, and conforms to the specified standards.

2.2 DISTRIBUTION EQUIPMENT AND SYSTEMS

A. Telecommunication Outlet (TCO):

1. The TCO shall consist of one telephone multi-pin jack and two data multi-pin jacks mounted in a steel outlet box. A separate 100mm (4in.) x 100mm (4in.) x 63mm (2.5in.) steel outlet box with a labeled stainless steel faceplate will be used. A second 100mm (4in.) x 100mm (4in.) x 63mm (2.5in.) steel outlet box with a labeled faceplate shall be provided as required adjacent to the first box to ensure system connections and expandability requirements are met.
2. All telephone multi-pin connections shall be RJ-45/1 1 compatible female types. All data multi-pin connections shall be RJ-45 female types.
3. The TCO shall be fed from the appropriate CCS located in the respective RTC in a manner to provide a uniform and balanced distribution system.
4. Interface of the data multi-pin jacks to appropriate patch panels (or approved "punch down" blocks) in the associated RTC, is the responsibility of the Contractor. The Contractor shall not extend data cables from the RTCs to data terminal equipment or install data terminal equipment.
5. The wall outlet shall be provided with a stainless steel or approve alternate cover plate to fit the telephone multi-pin jack, data multi-pin jacks and the outlet box provided (100mm (4in.) x 100mm (4in.) for single and 100mm (4in.) x 200mm (8in.) for dual outlet box applications). For PBPV installations, the cover plate shall be stainless steel.

- B. Distribution Cables: Each cable shall meet or exceed the following specifications for the specific type of cable. Each cable reel shall be sweep tested and certified by the OEM by tags affixed to each reel. The Contractor shall turn over all sweep tags to the COR or PM. Additionally; the Contractor shall provide a 610 mm (2 ft.) sample of each provided cable, to the COR and receive approval before installation. Cables installed in any outside location (i.e. above ground, underground in conduit, ducts, pathways, etc.) shall be filled with a waterproofing compound between outside jacket (not immediately touching any provided armor) and inter conductors to seal punctures in the jacket and protect the conductors from moisture.

1. Telephone:

- a. The System cable shall be provided by the Contractor to meet the minimum system requirements of Category 6a augmented service. The cable shall interconnect each part of the system. The cable shall be completely survivable in areas where it is installed.

b. Technical Characteristics:

Length	As required, in 1K (3,000 ft.) reels
Cable	Voice grade category 6a
Connectors	As required by system design
Size	22 AWG, minimum, Outside 24 AWG,
Color coding	Required, telephone industry standard
Bend radius	10X the cable outside diameter
Impedance	120 Ohms + 15%, BAL
Shield coverage	As required by OEM specification
Attenuation	
Frequency in MHz	dB per 305 M (1 ,000ft.), maximum
0.7	5.2
1.0	6.5
4.0	14.0
8.0	19.0
16.0	26.0
20.0	29.0
25.0	33.0
31.0	36.0
62.0	52.0
100.0	68.0

3. Data Multi-Conductor:

- a. The cable shall be multi-conductor, shielded or unshielded cable with stranded conductors. The cable shall be able to handle the power and voltage used over the distance required. It shall meet Category 6a service at a minimum.

b. Technical Characteristics:

Wire size	22 AWG, minimum
Working shield	350 V
Bend radius	10X the cable outside diameter
Impedance	100 Ohms + 15%, BAL
Bandwidth	500 MHz, minimum
DC RESISTANCE	10.0 Ohms/100M, maximum
Shield coverage	
Overall Outside (if OEM specified)	100%
Individual Pairs (if OEM	100%
Attenuation	
Frequency in mHz	dB per 305 M (1 ,000ft.), maximum
0.7	5.2
1.0	6.5
4.0	14.0
8.0	19.0
16.0	26.0
20.0	29.0
25.0	33.0
31.0	36.0
62.0	52.0
100.0	68.0

C. Outlet Connection

Cables: 1.

Telephone:

- a. The Contractor shall provide a connection cable for each TCO telephone jack in the System with 10% spares. The telephone connection cable shall connect the telephone instrument to the TCO telephone jack. The Contractor shall not provide telephone instrument(s) or equipment.

b. Technical Characteristics:

Length	1.8M (6ft.), minimum
Cable	Category 6a
Connector	RJ-1 1/45 compatible male on each end
Size	24 AWG, minimum
Color coding	Required, telephone industry

2. Data:

- a. The Contractor shall provide a connection cable for each TCO data jack in the system with 10% spares. The data connection cable shall connect a data instrument to the TCO data jack. The Contractor shall not provide data terminal(s)/equipment.

b. Technical Characteristics:

Length	1 .8M (6 ft.), minimum
Cable	Data grade Category 6a
Connector	RJ-45 male on each end
Color coding	Required, data industry standard
Size	24 AWG, minimum

D. System Connectors:

1. Solder-less (Forked Connector):

- a. The connector shall have a crimp-on coupling for quick connect/disconnect of wires or cables. The crimp-on connector shall be designed to fit the wire or cable furnished. The connector barrel shall be insulated and color-coded.

b. Technical Characteristics:

Impedance	As required
Working Voltage	500 V

2. Multi-pin:

- a. The connector shall have a crimp-on coupling for quick connect/disconnect of wires or cables. The crimp-on connector shall be designed to fit the wire or cable furnished. The connector housing shall be fully enclosed and shielded. It shall be secured to the cable group by screw type compression sleeves.

b. Technical Characteristics:

Impedance	As required
Working Voltage	500 V
Number of pins	As requires, usually 25 pairs minimum

4. Modular (RJ-45/1 1 and RJ-45): The connectors shall be commercial CAT 6a types for voice and high speed data transmission applications. The connector shall be compatible with telephone instruments, computer terminals, and other type devices requiring linking through the modular telecommunications outlet to the System. The connector shall be compatible with UTP and STP cables.

a. Technical Characteristics:

Type	Number of Pins
RJ-1 1/45	Compatible with RJ45
RJ-45	Eight
Dielectric	Surge
Voltage	1 ,000V RMS, 60 Hz @ one minute, minimum
Current	2.2A RMS @ 30 Minutes or 7.0A RMS @ 5.0 seconds
Leakage	100 µA, maximum
Connectability	
Initial contact	20 mili-Ohms, maximum
Insulation displacement	10 mili-Ohms, maximum
Interface	Must interface with modular jacks from a variety of OEMs. RJ-1 1/45 plugs
Durability	shall provide connection when used in 200 insertions/withdrawals, minimum

PART 3 - EXECUTION

3.1 INSTALLATION

A. Product Delivery, Storage and Handling:

1. Delivery: Deliver materials to the job site in OEM's original unopened containers, clearly labeled with the OEM's name and equipment catalog numbers, model and serial identification numbers. The COR may inventory the cable, patch panels, and related equipment.

2. Storage and Handling: Store and protect equipment in a manner, which will preclude damage as directed by the Contracting Officer's Technical Representative (COR).

B. System Installation:

1. After the contract's been awarded, and within the time period specified in the contract, the Contractor shall deliver the total system in a manner that fully complies with the requirements of this specification. The Contractor shall make no substitutions or changes in the System without written approval from the COR and PM.
2. The Contractor shall extend the system distribution cabling in a manner that complies with accepted industry standards of good practice, and in a manner which does not constitute a safety hazard. The Contractor shall insure that all installation personnel understands and complies with all the requirements of this specification.
3. The Contractor shall install suitable filters, traps, directional couplers, splitters, TC's, and pads for minimizing interference and for balancing the System. Items used for balancing and minimizing interference shall be able to pass telephone and data signals in the frequency bands selected, in the direction specified, with low loss, and high isolation, and with minimal delay of specified frequencies and signals. The Contractor shall provide all equipment necessary to meet the requirements of Paragraph 2.1 .C and the System performance standards.
4. All passive equipment shall be connected according to the OEM's specifications to insure future correct termination, isolation, impedance match, and signal level balance at each telephone/data outlet.
5. Any equipment installed indoors shall be installed in metal cabinets with hinged doors and locks with two keys.

C. Conduit:

1. Conduit:
 - a. The Contractor shall employ the latest installation practices and materials. The Contractor shall provide conduit, junction boxes, connectors, sleeves, and associated sealing materials not specifically identified in this document as GFE. Conduit

penetrations of walls, ceilings, floors, interstitial space, fire barriers, etc., shall be sleeved and sealed. The minimum conduit size shall be 19 mm (3/4 in.).

- b. All cables shall be installed in separate conduit and/or signal ducts (exception from the separate conduit requirement to allow telephone cables to be installed in partitioned cable tray with data cables may be granted in writing by the COR if requested.) Conduits shall be provided in accordance with Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS, and NEC Articles 517 for Critical Care and 800 for Communications systems, at a minimum.
 - c. When metal, plastic covered, etc., flexible cable protective armor or systems are specifically authorized to be provided for use in the System, their installation guidelines and standards shall be as specified herein, Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS, and the NEC.
 - d. When "inner-duct" flexible cable protective systems is specifically authorized to be provided for use in the System, its installation guidelines and standards shall be as the specified herein, Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS, and the NEC.
 - e. Conduit (including GFE) fill shall not exceed 40%. Each conduit end shall be equipped with a protective insulator or sleeve to cover the conduit end, connection nut or clamp, to protect the wire or cable during installation and remaining in the conduit. Electrical power conduit shall be installed in accordance with the NEC. AC power conduit shall be run separate from signal conduit.
 - f. When metal, plastic covered, etc., flexible cable protective armor or systems are specifically authorized to be provided for use in the System, their installation guidelines and standards shall be as specified herein, Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS, and the NEC.
2. Signal Duct, Cable Duct, or Cable Tray:
- a. The Contractor shall use existing signal duct, cable duct, and/or cable tray, when identified and approved by the RE.

- b. Approved signal and/or cable duct shall be a minimum size of 100 mm x 100 mm (4 in. X 4 in.) inside diameter with removable tops or sides, as appropriate. Protective sleeves, guides or barriers are required on all sharp corners, openings, anchors, bolts or screw ends, junction, interface and connection points.
 - c. Approved cable tray shall be fully covered, mechanically and physically partitioned for multiple electronic circuit use, and be UL certified and labeled for use with telecommunication circuits and/or systems. The COR shall approve width and height dimensions.
3. Routing and Interconnection:
- a. Wires or cables between consoles, cabinets, racks and other equipment shall be in an approved conduit, signal duct, cable duct, or cable tray that is secured to building structure.
 - b. Wires and cables shall be insulated to prevent contact with signal or current carrying conductors. Wires or cables used in assembling consoles, panels, equipment cabinets and racks shall be formed into harnesses that are bundled and tied. Harnessed wires or cables shall be combed straight, formed and dressed in either a vertical or horizontal relationship to equipment, controls, components or terminations.
 - c. Harnesses with intertwined members are not acceptable. Each wire or cable that breaks out from a harness for connection or termination shall have been tied off at that harness or bundle point, and be provided with a neatly formed service loop.
 - d. Wires and cables shall be grouped according to service (i.e.: AC, grounds, signal, DC, control, etc.). DC, control and signal cables may be included with any group. Wires and cables shall be neatly formed and shall not change position in the group throughout the conduit run. Wires and cables in approved signal duct, conduit, cable ducts, or cable trays shall be neatly formed, bundled, tied off in 600 mm to 900 mm (24 in. to 36 in.) lengths and shall not change position in the group throughout the run. Concealed splices are not allowed.
 - e. Separate, organize, bundle, and route wires or cables to restrict EMI, channel crosstalk, or feedback oscillation inside any enclosure. Looking at any enclosure from the rear (wall mounted enclosures, junction, pull or interface boxes from the

front), locate AC power, DC and speaker wires or cables on the left; coaxial, control, microphone and line level audio and data wires or cables, on the right. This installation shall be accomplished with ties and/or fasteners that will not damage or distort the wires or cables. Limit spacing between tied off points to a maximum of 150 mm (6 inches).

- f. Do not pull wire or cable through any box, fitting or enclosure where change of cable tray or signal or cable duct alignment or direction occurs. Ensure the proper bend radius is maintained for each wire or cable as specified by its OEM.
- g. Employ temporary guides, sheaves, rollers, and other necessary items to protect the wire or cable from excess tension or damage from bending during installation. Abrasion to wire or cable jackets is not acceptable and will not be allowed. Replace all cables whose jacket has been abraded. The discovery of any abraded and/or damaged cables during the proof of performance test shall be grounds for declaring the entire system unacceptable and the termination of the proof of performance test. Completely cover edges of wire or cable passing through holes in chassis, cabinets or racks, enclosures, pull or junction boxes, conduit, etc., with plastic or nylon grommets.
- h. Cable runs shall be splice free between conduit junction and interface boxes and equipment locations.
- i. Cables shall be installed and fastened without causing sharp bends or rubbing of the cables against sharp edges. Cables shall be fastened with hardware that will not damage or distort them.
- j. Cables shall be labeled with permanent markers at the terminals of the electronic and passive equipment and at each junction point in the System. The lettering on the cables shall correspond with the lettering on the record diagrams.
- k. Completely test all of the cables after installation and replace any defective cables.
- l. Wires or cables that are installed outside of buildings shall be in conduit, secured to solid building structures. If specifically approved, on a case by case basis, to be run outside of conduit, the wires or cables shall be installed, as described herein. The bundled wires or cables must: Be tied at not less than 460 mm (18 in.) intervals to a solid building structure; have ultra

violet protection and be totally waterproof (including all connections). The laying of wires or cables directly on roof tops, ladders, drooping down walls, walkways, floors, etc. is not allowed and will not be approved.

B. Outlet Boxes, Back Boxes, and Faceplates:

1. Outlet Boxes: Signal, power, interface, connection, distribution, and junction boxes shall be provided as required by the system design, on-site inspection, and review of the contract drawings.
2. Back Boxes: Back boxes shall be provided as directed by the OEM as required by the approved system design, on-site inspection, and review of the contract drawings.
3. Face Plates (or Cover Plates): Faceplates shall be of a standard type, stainless steel, anodized aluminum or UL approved cyclolac plastic construction and provided by the Contractor for each identified system outlet location. Connectors and jacks appearing on the faceplate shall be clearly and permanently marked.

C. Connectors: Circuits, transmission lines, and signal extensions shall have continuity, correct connection and polarity. A uniform polarity shall be maintained between all points in the system.

1. Wires:

- a. Wire ends shall be neatly formed and where insulation has been cut, heat shrink tubing shall be employed to secure the insulation on each wire. Tape of any type is not acceptable.
 - b. Audio spade lugs shall be installed on each wire (including spare or unused) end and connect to screw terminals of appropriate size barrier strips. AC barrier strips shall be provided with a protective cover to prevent accidental contact with wires carrying live AC current. Punch blocks are approved for signal, not AC wires. Wire Nut or "Scotch Lock" connectors are not acceptable for signal wire installation.
2. Cables: Each connector shall be designed for the specific size cable being used and installed with the OEM's approved installation tool. Typical system cable connectors include; but, are not limited to: Audio spade lug, punch block, wirewrap, etc.

D. AC Power: AC power wiring shall be run separately from signal cable.

E. Grounding:

1. General: The Contractor shall ground all Contractor Installed Equipment and identified Government Furnished Equipment to eliminate all shock hazards and to minimize, to the maximum extent possible, all ground loops, common mode returns, noise pickup, crosstalk, etc. The total ground resistance shall be 0.1 Ohm or less.
 - a. The Contractor shall install lightning arrestors and grounding in accordance with the NFPA and this specification.
 - b. Under no conditions shall the AC neutral, either in a power panel or in a receptacle outlet, be used for system control, subcarrier or audio reference ground.
 - c. The use of conduit, signal duct or cable trays as system or electrical ground is not acceptable and will not be permitted. These items may be used only for the dissipation of internally generated static charges (not to be confused with externally generated lightning) that may applied or generated outside the mechanical and/or physical confines of the System to earth ground. The discovery of improper system grounding shall be grounds to declare the System unacceptable and the termination of all system acceptance testing.
2. Cabinet Buss: A common ground buss of at least #10 AWG solid copper wire shall extend throughout each equipment cabinet and be connected to the system ground. Provide a separate isolated ground connection from each equipment cabinet ground buss to the system ground. Do not tie equipment ground busses together.
3. Equipment: Equipment shall be bonded to the cabinet bus with copper braid equivalent to at least #12 AWG. Self grounding equipment enclosures, racks or cabinets, that provide OEM certified functional ground connections through physical contact with installed equipment, are acceptable alternates.
4. Cable Shields: Cable shields shall be bonded to the cabinet ground buss with #12 AWG minimum stranded copper wire at only one end of the cable run. Cable shields shall be insulated from each other, faceplates, equipment racks, consoles, enclosures or cabinets; except, at the system common ground point.

F. Labeling: Provide labeling in accordance with ANSI/EIA/TIA-606-A. All lettering for voice and data circuits shall be stenciled using thermal ink transfer process. Handwritten labels are not acceptable.

1. Cable and Wires (Hereinafter referred to as "Cable"): Cables shall be labeled at both ends in accordance with ANSI/EIA/TIA-606-A. Labels shall be permanent in contrasting colors. Cables shall be identified according to the System "Record Wiring Diagrams".
2. Equipment: System equipment shall be permanently labeled with contrasting plastic laminate or bakelite material. System equipment shall be labeled on the face of the unit corresponding to its source.
3. Conduit, Cable Duct, and/or Cable Tray: The Contractor shall label all conduit, duct and tray, including utilized GFE, with permanent marking devices or spray painted stenciling a minimum of 3 meters (10 ft.) identifying it as the System. In addition, each enclosure shall be labeled according to this standard.
4. Termination Hardware: The Contractor shall label workstation outlets and patch panel connections using color coded labels with identifiers in accordance with ANSI/EIA/TIA-606-A and the "Record Wiring Diagrams".

3.2 WARRANTY

Contractor's Responsibilities: The Contractor shall warranty that all installed material and equipment will be free from defects, workmanship, and will remain so for a period of one year from date of final acceptance of the System by the VA. The Contractor shall provide system maintenance, equipment cleaning, and operational adjustments according to the OEM warranty

- - - E N D - - -

SECTION 27 15 00.16

REQUIREMENTS FOR VOICE COMMUNICATIONS HORIZONTAL CABLING

PART 1 GENERAL (NOT USED)

PART 2 PRODUCTS

2.1 HORIZONTAL ANALOG VOICE

- A. Category 6a plenum Voice cable will be white in color. All cable shall be plenum rated.
- B. No cable manufactured over a year before the installation date shall be installed.

2.2 CABLE SUPPORT SLING

- A. Constructed from steel and woven laminate; sling length can be adjusted to hold up to 425 4-pair UTP; rated for indoor use in non-corrosive environments. Rated to support Category 6a and higher cable, or optical fiber cable; UL Listed.
- B. Adjustable non-continuous cable support sling shall have a static load limit of 100 lbs.
- C. Adjustable non-continuous cable support sling shall be suitable for use in air handling spaces.
- D. ERICO CADDY CableCat CAT425, "J" hook with Velcro retaining strap
 - 1. Substitutions: Or equal with similar and salient characteristics. Submit in format noted in VAAR 811.104-71(b) and provide the required information on "equal" products, and to provide descriptive literature in accordance with FAR 52.14-21.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Topology
 - 1. Horizontal wiring for analog voice shall be configured in a star topology from the TER or TCs.

3.2 DISTANCE

- A. The maximum distance (cable run) between the outlet and the serving communications room shall be 90 meters (295 feet). Cable runs that exceed the 295 feet shall be submitted to OI&T Services in writing for a resolution.

NOTE: 100 Meters = 328 Feet

TC 7 Feet for patch cord to switch port.

TR 10 Feet for patch cord to Computer or other device.

Service Loop at TC 1 Foot for repunching/repair.

Service Loop at TR 20 Feet to allow for repair and relocation.

B. All cables are full run. Splices or inline connectors are not allowed.

3.3 PATHWAYS

A. Cable Caddy Supports

1. Erico Caddy Cablecat supports or equivalent will be used to support cables instead of hooks. The placement of caddy supports in the ceiling space shall facilitate the placement of cables, and shall be placed at a random distance between each support NOT TO EXCEED five feet to prevent uniform sag between cable supports which could have detrimental effects on the testing and transmission characteristics of the cabling. Multiple caddy support paths may be installed along a route if cable capacity requirements dictate. Caddy supports shall maintain a 40% or less fill capacity at installation. All supports will be physically attached to a structural member such that they meet 2005 NEC requirements. The bottom of the supports shall be between 8" and 12" from the ceiling grid. The caddy supports shall be placed away from other services in the ceiling (HVAC, fire, electrical, etc.) to provide adequate working clearance for the technicians. The minimum horizontal clearance from the access side of the support is 12" and must be maintained continuously between the supports. The caddy support and the intended cable pathway between supports shall have a minimum clearance of 12" on all sides from any fluorescent lighting fixtures.

B. The horizontal cabling shall be placed in the installed horizontal pathway system (cable tray, caddies, and/or sleeves) between the communication rooms and the outlets where available. Where existing cable tray is not available, the cable shall be installed in J-hooks at a minimum of four feet on center.

C. The cables shall not be tied to conduit in the ceiling, laid on duct work, strung across the ceiling grid, or otherwise be installed outside of the horizontal pathway system. In accordance with NEC 800-52(E), "Raceways shall be used for their intended purpose. Communication cables or wires shall not be strapped, taped, or attached by any means to the exterior of any conduit or raceway as a means of support."

D. The cables shall have no more than 8" sag between supports in the horizontal pathway system.

- E. The cables shall be dressed neatly and grouped in small bundles of 50 cables or less, of like purpose and color with loose hook and loop wraps that are suitable for air handling spaces. For example, only data cables shall be bundled together, only voice cables bundled together, only paging cables bundled together, etc.
- F. In the TCs and TER, the horizontal cables will be routed via the cable tray system and shall be dressed as appropriate with loose hook and loop wraps suitable for air handling spaces.
- G. TCO locations shall be a 4"x4"x (between 2.128" and 2.5") box with a 1" conduit for cables. This is also known as a quad box.

3.4 SERVICE LOOPS

- A. A 12" minimum service slack shall be left in the ceiling space at the outlet conduit for future re-terminations or repair, of the outlet. The slack shall be placed in the cables in a "staggered" fashion.
- B. In the communications rooms, a 12" minimum service slack shall be placed in a "staggered" fashion in the wire basket.

3.5 DAMAGED CABLES

- A. Any cables determined to be damaged shall be removed from the 110 blocks and pulled out of the pathway system and not left abandoned. A replacement cable(s) shall be pulled according to specification.

3.6 AVOIDANCE

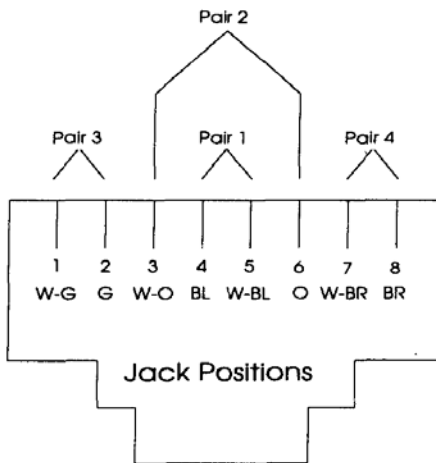
- A. The cables shall be installed with a minimum of 12" clearance from fluorescent lighting fixtures.

3.7 COMMUNICATIONS CLOSETS

- A. Cables shall be routed from the pathway system to the 110 termination block via cable tray.
- B. Cables of like purpose will be bundled with loose hook and loop wraps.
- C. Cables will be neatly dressed with loose hook and loop wraps.
- D. All cables shall be terminated TIA-568A pinouts.

The jack and pin/pair assignments for these modular jacks are shown in the illustrations below. These assignments are compatible with all known data applications intended to operate over 100-ohm twisted-pair cable.

Eight-Position Jack Pin/Pair Assignments (T568A)
(Front View of Connector)



END OF SECTION

SECTION 27 15 00.19

REQUIREMENTS FOR DATA COMMUNICATIONS HORIZONTAL CABLING

PART 1 GENERAL (NOT USED)

PART 2 PRODUCTS

2.1 HORIZONTAL DATA

- A. Category 6 plenum Data cable shall be Blue in color. All cable shall be plenum rated.
- B. No cable manufactured over a year before the installation date shall be installed.

2.2 CABLE SUPPORT SLING

- A. Constructed from steel and woven laminate; sling length can be adjusted to hold up to 425 4-pair UTP; rated for indoor use in non-corrosive environments. Rated to support Category 6a and higher cable, or optical fiber cable; UL Listed.
- B. Adjustable non-continuous cable support sling shall have a static load limit of 100 lbs.
- C. Adjustable non-continuous cable support sling shall be suitable for use in air handling spaces.
- D. ERICO CADDY CableCat CAT425, "J" hook with Velcro retaining strap
 - 1. Substitutions: Or equal with similar and salient characteristics. Submit in format noted in VAAR 811.104-71(b) and provide the required information on "equal" products, and to provide descriptive literature in accordance with FAR 52.14-21.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Topology.
 - 1. Horizontal wiring for analog voice shall be configured in a star topology from the TER or TCs.

3.2 DISTANCE

- A. The maximum distance (cable run) between the outlet and the serving communications room shall be 90 meters (295 feet). Cable runs that exceed the 295 feet shall be submitted to OI&T Services in writing for a resolution.

NOTE: 100 Meters = 328 Feet

TC 7 Feet for patch cord to switch port.

TR 10 Feet for patch cord to Computer or other device.

Service Loop at TC 1 Foot for repunching/repair.

Service Loop at TR 20 Feet to allow for repair and relocation.

B. All cables are full run. Splices or inline connectors are not allowed.

3.3 PATHWAYS

A. Cable Caddy Supports

1. Erico Caddy Cablecat supports or equivalent will be used to support cables instead of hooks. The placement of caddy supports in the ceiling space shall facilitate the placement of cables, and shall be placed at a random distance between each support NOT TO EXCEED five feet to prevent uniform sag between cable supports which could have detrimental effects on the testing and transmission characteristics of the cabling. Multiple caddy support paths may be installed along a route if cable capacity requirements dictate. Caddy supports shall maintain a 40% or less fill capacity at installation. All supports will be physically attached to a structural member such that they meet 2005 NEC requirements. The bottom of the supports shall be between 8" and 12" from the ceiling grid. The caddy supports shall be placed away from other services in the ceiling (HVAC, fire, electrical, etc.) to provide adequate working clearance for the technicians. The minimum horizontal clearance from the access side of the support is 12" and must be maintained continuously between the supports. The caddy support and the intended cable pathway between supports shall have a minimum clearance of 12" on all sides from any fluorescent lighting fixtures.

B. The horizontal cabling shall be placed in the installed horizontal pathway system (cable tray, caddies, and/or sleeves) where available between the communication rooms and the outlets. Where existing cable tray is not available, the cable shall be installed in J-hooks at a minimum of four feet on center.

C. The cables shall not be tied to conduit in the ceiling, laid on duct work, strung across the ceiling grid, or otherwise be installed outside of the horizontal pathway system. In accordance with NEC 800-52(E), "Raceways shall be used for their intended purpose."

Communication cables or wires shall not be strapped, taped, or attached by any means to the exterior of any conduit or raceway as a means of support."

- D. The cables shall have no more than 8" sag between supports in the horizontal pathway system.
- E. The cables shall be dressed neatly and grouped in small bundles of 50 cables or less, of like purpose and color with loose hook and loop wraps that are suitable for air handling spaces. For example, only data cables shall be bundled together, only voice cables bundled together, only paging cables bundled together, etc.
- F. In the TCs and TER, the horizontal cables will be routed via the cable tray system and shall be dressed as appropriate with loose hook and loop wraps suitable for air handling spaces.
- G. TCO locations shall be a 4"x4"x (between 2.128" and 2.5") box with a 1" conduit for cables. This is also known as a quad box.

3.4 SERVICE LOOPS

- A. A 12" minimum service slack shall be left in the ceiling space at the outlet conduit for future re-terminations or repair, of the outlet. The slack shall be placed in the cables in a "staggered" fashion.
- B. In the communications rooms, a 12" minimum service slack shall be placed in a "staggered" fashion in the wire basket.

3.5 DAMAGED CABLES

- A. Any cables determined to be damaged shall be removed from the patch panels and pulled out of the pathway system and not left abandoned. A replacement cable(s) shall be pulled according to specification.

3.6 AVOIDANCE

- A. The cables shall be installed with a minimum of 12" clearance from fluorescent lighting fixtures.

3.7 COMMUNICATIONS CLOSETS

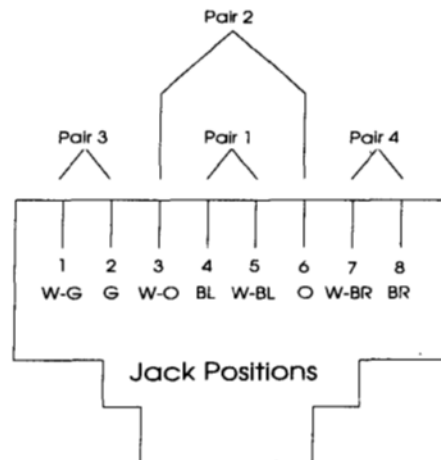
- A. Cables shall be routed from the pathway system to the rack via wire basket.
- B. Cables of like purpose will be bundled with loose hook and loop wraps.
- C. Cables will turn down into the back of the vertical management. They will then turn and exit from the vertical management at the patch panel on which they are to be terminated. Cables for the left side of

the patch panel will be routed on the left vertical management. Cables for the right side of the patch panel will be routed on the right vertical management. At no time shall cables cross the center point of the patch panel.

- D. Cables will be neatly dressed with loose hook and loop wraps.
- E. All cable terminations shall be TIA-568A Pinout.

The jack and pin/pair assignments for these modular jacks are shown in the illustrations below. These assignments are compatible with all known data applications intended to operate over 100-ohm twisted-pair cable.

**Eight-Position Jack Pin/Pair Assignments (T568A)
(Front View of Connector)**



END OF SECTION

SECTION 27 2100

DATA COMMUNICATIONS NETWORK EQUIPMENT

PART 1 - GENERAL

These specifications shall be utilized for the extension and connection to an existing Data Communications Network.

1.1 SCOPE OF WORK

- A. Furnish and install as required and as indicated on the drawings, all necessary connection to layer 2 network switch chassis with 3 each 48 port modules, management capable in wiring closets to activate each new wired data jack terminated in each wiring closet
- B. Furnish and install as required and indicated on the drawings, UTP patch cables to connect Network Electronics to station cable patch panels in each wiring closet are provided under specification SECTION 27 15 00, COMMUNICATIONS HORIZONTAL CABLING. This contract shall be responsible for installing and labeling all new patch cables from patch panels to network electronics.

1.2 SYSTEM DESCRIPTION

- A. The Network Electronics has full-duplex, auto-sensing 10/100/1000 BASETX UTP, Ethernet ports for all wired data jacks. The edge switch unit shall provide full layer 2 switching.
- B. The Network Electronics has full duplex Gigabit uplink modules in the primary switch to connect to the main wiring closet.
- C. The Network Electronics has software management capabilities such as Virtual LANs (VLANs), Multilevel access security, and Group management protocol. Software management shall be web-based and utilize a standard web browser. VLAN trunks shall be capable of being created from any port on any switch using IEEE 802.1Q standards based tagging. The main switch chassis has full Layer 2 and basic Layer 3 switching and **routing (with upgrade to full layer 3 through firmware)**.
- D. The Network Electronics has features associated with Quality of Service (QoS) and Class of Service (CoS) as well as port-based prioritization. The QoS shall be based upon IEEE 802.1

1.3 QUALITY ASSURANCE

- A. Any new system component shall be UL listed.
- B. Installation shall be in compliance with the National Electric Code and all other applicable codes.

- C. All materials furnished under this contract shall be new, of highest quality and shall be of a regularly manufactured line, currently in production at the time of installation.

1.4 CONTRACTOR QUALIFICATIONS

- A. It shall not be acceptable for the contractor to utilize a subcontractor for any portion of the work, unless the subcontractor has been approved in writing by the Engineer based upon adherence to the qualifications listed herein.
- B. The Contractor shall maintain a fully equipped, factory certified service organization capable of providing full maintenance and service of the installed system within 24 hours. This facility shall be available for inspection by the Engineer.
- C. The Contractor shall employ factory trained service personnel for the service and maintenance of the system.
- D. The Contractor shall have had a minimum of 1 year experience with the specified Network Electronics. This experience shall include having completed a minimum of 2 installations in the past 12 months of similar size and scope. The Contractor shall provide references and contact information for the project sites in which the qualifying installations occurred.

1.5 SHOP DRAWINGS

- A. Submit shop drawings including product data sheets and wiring diagrams per requirements in the General Conditions including the following:
 - 1. Shop drawings including product and cable data sheets and wiring diagrams specific to the project. Data sheets shall indicate exact model numbers and options specific to the project.
 - 2. A complete bill of material including cables, connectors, etc. with model and part numbers.
 - 3. Job specific System block diagram. This indicates a block diagram that shows all items of equipment required for the contract project and the actual interconnection that will be installed.
 - 4. Supplier shall provide rack elevations showing configuration of all rack mounted equipment including detailed interconnection diagrams between items of equipment.
 - 5. Submittals that do not contain the above information will be rejected.

PART 2 PRODUCTS

2.1 PATCH CABLES

- A. This contract shall be responsible for providing as required fiber and copper patch cables at switch uplink. The following patch cables requirements are considered part of these specifications:
- B. Copper patch cable - If required, provide patch cables at edge switch requiring copper uplink ports and copper patch cables at copper 1000BASE TX port in the chassis switch. Patch cables to match the EIA/TIA channel configuration of the cabling system. Coordinate patch cable length and color to provide a neat, orderly and workman like appearance after system patching is complete.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General Installation
 - 1. Install system extension in accordance with UL, NEC and all other applicable codes. Install system extension to comply with drawings. Provide all required hardware and labor for rack mounting of any new system component.
 - 2. Provide any miscellaneous equipment such as identification tags, cable tie, wiring harnesses, patch cables (both copper and fiber), stacking cables etc. necessary for a complete TURNKEY system.
 - 3. Provide all required jumper and patch cables and coordination with the Owner to connect to the Owner's File Server(s).

3.2 GROUNDING

- A. The installing contractor shall be responsible for ensuring the grounding integrity of all installed equipment to eliminate the potential for equipment or personnel hazards due to improperly or inadequately grounded systems.
- B. All grounding and bonding shall be in conformance with the National Electric Code, article 250 and as recommended by EIA/TIA-607.
- C. The Division 26 Contractor has provided 1 20V branch circuitry for use by the contractor. The branch circuitry is run with a dedicated equipment grounding conductor which shall be utilized by the system equipment. In no case shall the installation compromise the integrity of the Building Electrical Grounding System.

3.3 TELECOMMUNICATION ROOMS

- A. The lay-out of the telecommunications rooms as depicted on the drawings shall be utilized as a general guide for bidding purposes.

3.4 IDENTIFICATION/LABELING

- A. Contractor shall identify all items of equipment and tag all cables furnished by him for this project, with permanent type markers to denote equipment served. Cables shall be tagged at both ends and at each point where the cable is administered.
- B. The contractor shall be responsible for applying a permanent label to each fiber/copper patch cable furnished by him for this project to indicate source and destination. This label shall indicate patch panel and port at switch side and switch and port at patch panel side. Fiber jumpers utilized to serve uplinks to remote switches shall be labeled with closet and switch on chassis side and fiber port in chassis on switch side.
- C. All labeling and recording shall be approved by the Owner and the Engineer prior to application.
- D. Provide a printed, computer generated record of any new port connection in each switch. Label shall indicate data jack label, port and switch label and closet label.

3.5 TESTING

- A. The Contractor shall be responsible for energizing and testing any new port activated by him as related to this project.. This test shall include "rack-to-jack" and from main switch to switch "stacks". The contractor shall be responsible for ensuring that the network is in proper working condition.
- B. The Contractor shall be responsible for testing and verifying that all software and management level functions of the system as required by the Owner's Network system are programmed and operating properly.

3.6 TRAINING

- A. Demonstrate adjustment, operation and maintenance of the system extension including each component and control installed.

3.7 AS-BUILT DOCUMENTATION

- A. The Contractor shall furnish the Owner
 - 1. As-Built Drawings of the System extension installed by him.

3.8 WARRANTY

- A. If any defects are found within the two (2) year full warranty period, the defective system component shall be replaced at no extra cost to the Owner for parts or labor. Provide a statement of this warranty with the O&M Manuals.
- B. During the warranted operation, the Contractor shall perform two inspections at 6- month intervals or less. This work shall be performed during regular working hours, Monday through Friday, excluding legal holidays. Resolve any previous outstanding problems.
- C. Make available a service contract offering continuing factory authorized service of this system after the initial warranty period.
- D. The Contractor shall be responsible to provide service during normal working hours on a normal business day within (8) hours after notification by the Owner for normal service or within (4) hours for emergency service. Emergency service is defined as the loss of 25% or more of system components operation, or the loss of the main switch or other head-end equipment which renders the entire system beyond 50% inactive or un-usable. Provide an on-site authorized factory technician within 24 hours if required.
- E. If equipment cannot be repaired within 24 hours of service visit, Contractor shall provide "loaner" equipment to the Owner at no charge.

3.9 CERTIFICATION

- A. Upon completion of the testing, the manufacturer or representative shall issue to the Owner a letter of certification attesting to the fact that he has tested and adjusted the system, that all components are properly installed and free of defects, and that the system is in compliance with this specification.

END OF SECTION

SECTION 27 4141
CATV SYSTEM - EXTENSION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing, installing, connecting and testing of a cabling extension of an existing master antenna TV system.
- B. Interface the master antenna system extension with the existing systems and distribute the television signals to locations indicated on the drawings..

1.2 RELATED WORK

- A. Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS for general requirements that are common to all sections of Division 27.
- B. Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS for raceways, fittings and boxes used as pathways for master antenna system extension cabling.

1.3 SYSTEM DESCRIPTION

- A. The MATV Extension system shall provide adjacent channel operation of the 35 television channels currently distributed at the site.
- B. The Contractor is not responsible for the condition of the signals of the existing MATV system.
- C. The system shall include: Horizontal RG-6 cable with type "F" connectors and faceplates, wall/rack mounted type "F" patch panels in the TR, quad shielded type RG-11 backbone/riser cabling from the ER to each RTC, labeling, testing.
- D. System layout that loops the RF cable from room to room is not acceptable. Each outlet shall be a "homerun" to the local CATV patch panel in the RTC.
- E. The MATV Extension system shall connect TV receivers as follows:
 - 1. Standard CATV capable TV receivers to the designated TV outlets in the project areas.as shown on plan.

1.4 PERFORMANCE REQUIREMENTS

- A. The signal level of each channel at each TV outlet shall be ± 10 dBmV, plus or minus 5 dB across 75 Ohms:
 - 1. NHCU: The signal level at the Power Distribution Room TV outlet shall be ± 25 dBmV, plus or minus 2 dB across 75 Ohms.

- B. The MATV Extension system shall meet the following minimum parameters at each new TV outlet. The signal quality at the interface point shall not be less than the stated minimum parameters:
 - 1. Signal-To-Noise Ratio: -44 dB
 - 2. Cross Modulation: -46 dB
 - 3. Hum Modulation: -55 dB
 - 4. Return Loss: -14 dB
 - 5. Isolation (outlet-outlet): 24 dB
 - 6. Visual to Aural Carrier Ratio: 13 dB to 17 dB below visual
 - 7. Impedance: 75 ohms

1.5 QUALITY ASSURANCE

- A. Field Quality Assurance:
 - 1. Test Plan: Submit the test plan prior to pretesting for evaluation and approval.
 - 2. Submit test reports.
- B. Samples: A sample of each of the following items shall be furnished to the COR for approval prior to installation. The samples may be returned to the Contractor at the discretion of the COR.
 - 1. RG-6 Station Cabling
 - 2. Wall Outlet Box 100 x 100 mm (4" x 4"), or two 50 x 100 mm (2" X 4") outlet boxes, with:
 - a. RF Outlet installed
 - b. Multi-pin jack installed
 - c. Stainless Cover Plate installed
 - d. AC Outlets installed
 - e. Steel Partition installed
- C. Warranty Period: List the entities that will certify the system and who will perform the warranty services. The listing shall include a company brochure, and name - title - normal and emergency telephone numbers of the individuals providing the services.

1.7 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in text by basic designation only.
- B. National Fire Protection Association (NFPA):
 - 70-0511.....National Electrical Code
 - 780-04.....Standard for the Installation of
Lightning Protection Systems

- 99-05.....Standard for Health Care Facilities
- C. Underwriters Laboratories, Inc. (UL)
 - 1410-97 (R01).....Television Receivers and High-Voltage Video Products
 - 1069-01 (R06).....Standard for Hospital Signaling and Nurse Call Equipment

1.8 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver materials to the job site in manufacturer's original unopened containers, clearly labeled with the manufacturer's name and equipment model identification number.
- B. Storage and Handling: Store and protect equipment in a manner which will preclude damage.

2.5 COAXIAL CABLE - HORIZONTAL STATION

- A. The coaxial cable shall be an RG-6 double shielded, certified 100% sweep tested by the manufacturer by tags on each reel. The tags and a two foot sample shall be delivered to the COR prior to installation. The cable shall be able to pass the frequency spectrum from 5 to 890 MHz.
 - 1. Center Conductor: 18 AWG copper-clad steel
 - 2. Dielectric: Foam
 - 3. Jacket: Black PVC or PE, UL 1685 Type CATV or CM
 - 4. Temperature Rating: 80 degrees C
 - 5. Impedance: 75 Ohm
- B. Attenuation for the following frequencies at a maximum indicated dB per 30 m (100 feet):
 - 1. 7 MHz: 0.6
 - 2. 54 MHz: 1.8
 - 3. 216 MHz: 3.5
 - 4. 470 MHz: 4.7
 - 5. 890 MHz: 7.0
- C. Coaxial Cable Terminators: These units shall be metal housed precision types in the frequency ranges selected.
 - 1. Frequency:
 - a. 5-890 MHz.
 - b. 200-1500 MHz.
 - c. 3000-5000 MHz.
 - 2. Power Blocking: As required, 1.5:1 Max.
 - 3. Return Loss: 25 dB.

4. Connectors: "F", unless otherwise indicated.
5. Impedance: 75 Ohms, unless otherwise indicated.

2.6 TV RECEIVER CONNECTIONS

- A. Coaxial Cable: Provide one connecting cable for each TV outlet in the MATV system plus 10% spares. The cable shall connect the TV receiver to the RF jack.
 1. Length: 1800 mm (6 feet).
 2. Cable: RG-6 double shielded type.
 3. Connector: Snap-on "F" at MATV outlet end and screw-on "F" at receiver end.
- B. TV Receiver Matching Transformer: Provide 75 to 300 Ohm matching transformers, in a quantity equal to 10% of the TV wall outlets. The matching transformer shall have metal case or other means to reduce local pickup (ghosting) at the TV receiver input.
 1. Insertion loss: UHF - 1.5 dB, VHF - 0.5 dB.
 2. Return loss: UHF - 12 dB, VHF - 20 dB.
 3. Balance: UHF - 30 dB, VHF - 35 d.
- C. TV Receiver Ceiling/Wall Mount:
 1. Install mounts where indicated, using factory made accessories, braces and back plates, as needed for secure mounting.
 2. The mount shall be able to be swiveled, tilted and locked, and be adjustable in width for 480 mm (19") TV receivers.
 3. The installation of mounts shall be approved by the COR. Allow at least 1980 mm (78 inches) headroom under the mount when installed in a location where personnel may walk directly under it.

2.7 RF CONNECTORS:

- A. "F" Connectors: Screw type coupling for quick connect/disconnect of coaxial cable terminations. Crimp on integral ferrule connector designed to fit the coaxial cable furnished.
 1. Working Voltage: 500 V.
 2. Frequency Range: 0 to 890 MHz.
 3. Impedance: 75 Ohms.
- B. "UHF" Connectors: Screw type coupling for quick connect/disconnect of coaxial cable terminations. It shall be a crimp on connector designed to fit the coaxial cable furnished.
 1. Working Voltage: 500 V.
 2. Frequency Range: 0 to 890 MHz.
 3. Impedance: 75 Ohms.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install equipment according to NFPA 70, accepted industry standards of good practice, the requirements of this specification, and in a manner which does not constitute a safety hazard: 1. Comply with NECA 1.
- B. Insure that installation personnel understand the requirements of this specification.
- C. Connect passive equipment according to the manufacturer's specification to insure correct termination, isolation impedance match, and signal level balance at each outlet.
- D. Identification: Cables shall be labeled with permanent markers at the terminals of the electronic and passive equipment. The lettering on the cables shall correspond with the lettering on the as- installed diagrams.
- E. Outlet Installation: Install MATV outlets for each receiver.
- F. Cable Terminations:
 - 1. All lines shall be terminated in a suitable manner to facilitate future expansion of the MATV system. There shall be a minimum of one spare output at each distribution point on each floor.

3.2 SYSTEM CABLING:

- A. Install cabling in raceway, and cable tray, except within cabinets. Conceal raceway and cables, except in unfinished spaces. MATV cables shall not be installed in AC power conduits:
 - 1. Cable in raceway shall be NFPA Type CMG.
 - 2. Cable in cable tray in environmental air spaces, shall be non-plenum unless it is a plenum ceiling space, then cable shall be plenum rated.
- B. Raceway and boxes shall be as specified in Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS.
- C. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at outlets, equipment terminals, and in terminal cabinets. Cables may not be spliced:
 - 1. Connectors shall be installed using the connector manufacturer's approved crimping tool.
- D. Cold-weather installation: Bring cable to room temperature before dereeling. Heat lamps may not be used.

3.3 AC POWER

- A. Connect branch AC circuits which supply power to the MATV system to a single panel board and shall clearly indicate on the directory in the panel board that the circuits supply power to the system.
- B. Install a 120 volt AC branch circuit, wired to a separate breaker, from the power panel to each equipment cabinet:
 - 1. Provide AC power outlets that are convenient to each item of equipment in the equipment cabinet and to each TV receiver wall outlet.

3.4 GROUNDING

- A. Ground installed equipment in accordance with the Section 27 05 26, GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS to eliminate shock hazards and to minimize ground loops, noise pickup, or other interferences:
 - 1. Ground wires for equipment shall be at least No. 14 AWG stranded copper wire.
 - 2. Ground wires for equipment cabinets or racks shall be at least No. 10 AWG stranded copper wire.

3.6 TESTS

- A. Pretesting:
 - 1. System shall be tested end-to-end complete by and a certificate of inspection shall be furnished by a qualified manufacturer's representative or equipment vendor; submit report to the Architect
 - 2. In addition, each cable shall be tested prior to installation for impedance, time domain and structural return loss.
 - 3. Testing shall verify cable continuity and nominal Impedance. TDR test for determining final cable length
 - 4. In addition, each cable shall be tested prior to installation for impedance, time domain and structural return loss.
 - 5. This Contractor shall provide the following tests with results to indicate conformance with the specifications at each outlet:
 - a. Cable Continuity
 - b. Nominal Impedance
 - c. TDR test for determining final cable length.
- B. Acceptance Testing:
 - 1. Notify the COR in writing seven days after the pre-test has been completed and 30 days prior to the date acceptance testing is expected to begin. Test system in the presence of a

Government Representative. Verify that the system extension meets the requirements of the **specification and complies with all appropriate standards listed in this specification.**

2. The notification of the acceptance test shall include the expected length of the test in days.
3. The acceptance test shall be performed on a "go/no-go" basis. Only those operator adjustments required to show proof-of-performance shall be allowed. The test shall demonstrate and verify that the installed MATV system does comply with the operational and technical requirements of this specification under operating conditions. The MATV system shall be rated as either acceptable or unacceptable at the conclusion of the test. Failure of any part of the system which precludes completion of system testing, which cannot be repaired in four (4) hours, shall be cause for terminating the test of the MATV system. Repeated failures which result in a cumulative time of eight (8) hours to effect repairs shall cause the entire MATV system to be declared unacceptable. Retesting of the entire MATV system shall be rescheduled at the convenience of the Government.

B. Acceptance Test Procedure: 1. Inspection:

1. Procedure: 1. Inspection:
 - a. The Government representative will tour major areas to insure that MATV system extension are completely and properly installed in place, and are operationally ready for proof-of-performance testing. Failure of the MATV system to meet the installation requirements of this specification shall be grounds for terminating all testing.
 - b. The MATV system diagrams, as-installed drawings, equipment manuals, AUTO CAD Disks, and pretest measurements shall be reviewed before testing is resumed.
2. Revise as-installed wiring diagrams to show adjustments made during acceptance testing.

- - - E N D - - -

SECTION 27 51 16
PUBLIC ADDRESS, MUSIC AND PAGING SYSTEMS

PART 1 - GENERAL

1.1 SECTION SUMMARY

- A. Work covered by this document includes labor, material and products, equipment warranty and system guarantee, training and services for, and incidental to, the complete installation of a new Public Address System (PAS), Music, Paging and associated equipment (here-in-after referred to as the System). These items shall be tested and certified capable of receiving, distributing, interconnecting and supporting PAS communications signals generated local and remotely as detailed herein.
 - B. Work shall be complete, Occupational Safety and Health Administration (OSHA), National Recognized Testing Laboratory (NRTL - i.e., Underwriters Laboratories [UL]) Listed and Labeled; and VAMC Central Office (VACO), Telecommunications Voice Engineering (TVE 0050P3B) tested, certified and ready for operation.
 - C. The System shall be delivered free of engineering, manufacturing, installation, and functional defects. It shall be installed for ease of operation, maintenance, and testing.
 - D. The term "provide", as used herein, shall be defined as: designed, furnished, installed, certified, and tested, by the Contractor.
 - E. Specification Order of Precedence: In the event of a conflict between the text of this document and the Project's Contract Drawings outlined and/or cited herein; **THE TEXT OF THIS DOCUMENT TAKES PRECEDENCE.** *HOWEVER, NOTHING IN THIS DOCUMENT WILL SUPERSEDE APPLICABLE EMERGENCY LAWS AND REGULATIONS, SPECIFICALLY NATIONAL AND/OR LOCAL LIFE AND PUBLIC SAFETY CODES.* The Local Fire Marshall and/or VAMC Public Safety Officer are the only authorities that may modify this document's EMERGENCY CODE COMPLIANCE REQUIREMENTS, on a case by case basis, in writing and confirmed by VAMC's COR and TVE-0050P3B. The VAMC COR is the only approving authority for other amendments to this document that may be granted, on a case by case basis, in writhing with technical concurrencies by VAMC's COR, TVE-0050P3B and identified Facility Project Personnel.
1. The Contracting Officer is the only Government official with the authority to legally modify the contract with respect to any changes in the contract requirements.

F. The Original Equipment Manufacturer (OEM) and Contractor shall ensure that all management, sales, engineering and installation personnel have read and understand the requirements of this specification before the system is designed, engineered, delivered and provided. The Contractor shall furnish a written statement attesting this requirement as a part of the technical submittal that includes each name and certification, including the OEMs.

1.2 RELATED SECTIONS

- A. 01 33 23 - Shop Drawings, Product Data and Samples.
- B. 07 84 00 - Firestopping.
- C. 26 05 21 - Low - Voltage Electrical Power Conductors and Cables (600 Volts and Below).
- E. 27 05 11 - Requirements for Communications Installations.
- F. 27 05 26 - Grounding and Bonding for Communications Systems.
- G. 27 05 33 - Raceways and Boxes for Communications Systems.
- H. 27 10 00 - Structured Communications Cabling Equipment and Systems.
- I. 27 11 00 - Communications Cabling Interface and Equipment Rooms Fittings.

1.3 DEFINITIONS

- A. Provide: Furnish, install, connect complete, test, certify and guarantee.
- B. Work: Materials furnished and completely installed.
- C. Review of contract drawings: A service by the engineer to reduce the possibility of materials being ordered which do not comply with contract documents. The engineer's review shall not relieve the Contractor of responsibility for dimensions or compliance with the contract documents. The reviewer's failure to detect an error does not constitute permission for the Contractor to proceed in error.
- D. Headquarters Technical Review, for National and VAMC communications and security, codes, frequency licensing, standards, guidelines compliance:
 - Office of Telecommunications
 - Special Communications Team (0050P2B)
 - 1335 East West Highway - 3rd Floor
 - Silver Spring, Maryland 20910
 - (O) 301-734-0350, (F) 301-734-0360
- E. Contractor: Radio Contractor; you; successful bidder

1.4 REFERENCES

A. The installation shall comply fully with all governing authorities, laws and ordinances, regulations, codes and standards, including:

1. United States Federal Law:

a. Departments of:

1) Commerce, Consolidated Federal Regulations (CFR), Title 15 - Under the Information Technology Management Reform Act (Public Law 104-106), the Secretary of Commerce approves standards and guidelines that are developed by the:

a) Chapter II, National Institute of Standards Technology (NIST - formerly the National Bureau of Standards). Under Section 5131 of the Information Technology Management Reform Act of 1996 and the Federal Information Security Management Act of 2002 (Public Law 107-347), NIST develops - Federal Information Processing Standards Publication (FIPS) 140-2-Security Requirements for Cryptographic Modules.

b) Chapter XXIII, National Telecommunications and Information Administration (NTIA - aka 'Red Book') Chapter 7.8 / 9; CFR, Title 47 Federal communications Commission (FCC) Part 15, Radio Frequency Restriction of Use and Compliance in "Safety of Life" Functions & Locations

2) FCC - Communications Act of 1934, as amended, CFR, Title 47 - Telecommunications, in addition to Part 15 - Restrictions of use for Part 15 listed Radio Equipment in Safety of Life / Emergency Functions / Equipment/ Locations (also see CFR, Title 15 - Department of Commerce, Chapter XXIII - NTIA):

a) Part 15 - Restrictions of use for Part 15 listed Radio Equipment in Safety of Life / Emergency Functions / Equipment/Locations.

b) Part 58 - Television Broadcast Service.

c) Part 90 - Rules and Regulations, Appendix C.

d) Form 854 - Antenna Structure Registration.

3) Health, (Public Law 96-88), CFR, Title 42, Chapter IV Health & Human Services, CFR, Title 46, Subpart 1395(a)(b) JCAHO "a hospital that meets JCAHO accreditation is deemed to meet the Medicare conditions of Participation by meeting Federal Directives:"

- a) All guidelines for Life, Personal and Public Safety; and, Essential and Emergency Communications.
- 4) Labor, CFR, Title 29, Part 1910, Chapter XVII - Occupational Safety and Health Administration (OSHA), Occupational Safety and Health Standard:
 - a) Subpart 7 - Definition and requirements (for a NRTL - 15 Laboratory, for complete list, contact [\(\[http://www.osha.gov/dts/otpca/nrtl/faq_nrtl.html\]\(http://www.osha.gov/dts/otpca/nrtl/faq_nrtl.html\)\)](http://www.osha.gov/dts/otpca/nrtl/faq_nrtl.html)):
 - 1) UL:
 - a) 44-02 - Standard for Thermoset-Insulated Wires and Cables.
 - b) 65 - Standard for Wired Cabinets.
 - c) 83-03 - Standard for Thermoplastic-Insulated Wires and Cables.
 - d) 467-01 - Standard for Electrical Grounding and Bonding Equipment
 - e) 468 - Standard for Grounding and Bonding Equipment.
 - f) 486A-01 - Standard for Wire Connectors and Soldering Lugs for Use with Copper Conductors
 - g) 486C-02 - Standard for Splicing Wire Connectors.
 - h) 486D-02 - Standard for Insulated Wire Connector Systems for Underground Use or in Damp or Wet Locations.
 - i) 486E-00 - Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors.
 - j) 493-01 - Standard for Thermoplastic-Insulated Underground Feeder and Branch Circuit Cable.
 - k) 514B-02 - Standard for Fittings for Cable and Conduit.
 - l) 1069 - Hospital Signaling and Nurse Call Equipment.
 - m) 1333 - Vertical (Riser) Fire Rating.
 - n) 1449 - Standard for Transient Voltage Surge Suppressors.
 - o) 1479-03 - Standard for Fire Tests of Through-Penetration Fire Stops.
 - p) 1863 - Standard for Safety, Communications Circuits Accessories.
 - q) 2024 - Standard for Optical Fiber Raceways.

- r) 60950-1/2 - Information Technology Equipment - Safety.
- 2) Canadian Standards Association (CSA): same tests as for UL.
- 3) Communications Certifications Laboratory (CCL): same tests as for UL.
- 4) Intertek Testing Services NA, Inc. (ITSNA formerly Edison Testing Laboratory [ETL]): same tests as for UL.
- b) Subpart 35 - Compliance with NFPA 101 - Life Safety Code.
- c) Subpart 36 - Design and construction requirements for exit routes.
- d) Subpart 268 - Telecommunications.
- e) Subpart 305 - Wiring methods, components, and equipment for general use.
- 5) Department of Transportation, CFR, Title 49 (Public Law 89-670), Part 1, Subpart C - Federal Aviation Administration (FAA):
 - a) Standards AC 110/460-ID & AC 707 / 460-2E - Advisory Circulars for Construction of Antenna Towers.
 - b) Forms 7450 and 7460-2 - Antenna Construction Registration.
- 6) Veterans Affairs (Public Law No. 100-527), CFR, Title 38, Volumes I & II:
 - a) Office of Telecommunications:
 - 1) Handbook 6100 - Telecommunications.
 - a) Spectrum Management FCC & NTIA Radio Frequency Compliance and Licensing Program.
 - b) Special Communications Proof of Performance Testing, VACO Compliance and Life Safety Certification(s).
 - b) Office of Cyber and Information Security (OCIS):
 - 1) Handbook 6500 - Information Security Program.
 - 2) Wireless and Handheld Device Security Guideline Version 3.2, August 15, 2005.
 - c) VAMC's National Center for Patient Safety - Veterans Health Administration Warning System, Failure of Medical Alarm Systems using Paging Technology to Notify Clinical Staff, July 2004.

- d) VAMC's Center for Engineering Occupational Safety and Health, concurrence with warning identified in VAMC Directive 7700.
- e) Office of Construction and Facilities Management (CFM):
 - 1) Master Construction Specifications (PG-18-1).
 - 2) Standard Detail and CAD Standards (PG-18-4).
 - 3) Equipment Guide List (PG-18-5).
 - 4) Electrical Design Manual for VAMC Facilities (PG 18-10), Articles 7 & 8.
 - 5) Minimum Requirements of A/E Submissions (PG 18-15):
 - a) Volume B, Major New Facilities, Major Additions; and Major Renovations, Article VI, Paragraph B.
 - b) Volume C - Minor and NRM Projects, Article III, Paragraph S.
 - c) Volume E - Request for Proposals Design/Build Projects, Article II, Paragraph F.
- b. Federal Specifications (Fed. Specs.):
 - 1) A-A-59544-00 - Cable and Wire, Electrical (Power, Fixed Installation).
- 2. United States National Codes:
 - a. American Institute of Architects (AIA): Guidelines for Healthcare Facilities.
 - b. American National Standards Institute/Electronic Industries Association/Telecommunications Industry Association (ANSI/EIA/TIA):
 - 1) 568-B - Commercial Building Telecommunications Wiring Standards:
 - a) B-1 - General Requirements.
 - b) B-2 - Balanced twisted-pair cable systems.
 - c) B-3 - Fiber optic cable systems.
 - 2) 569 - Commercial Building Standard for Telecommunications Pathways and Spaces.
 - 3) 606 - Administration Standard for the Telecommunications Infrastructure of Communications Buildings.
 - 4) 607 - Commercial Building Grounding and Bonding Requirements for Telecommunications.
 - 5) REC 127-49 - Power Supplies.
 - 6) RS 160-51 - Sound systems.

- 7) RS 270 - Tools, Crimping, Solderless Wiring Devices,
Recommended Procedures for User Certification.
- 8) SE 101-A49 - Amplifier for Sound Equipment
- 9) SE 103-49 - Speakers for Sound Equipment
- c. American Society of Mechanical Engineers (ASME):
 - 1) Standard 17.4 - Guide for Emergency Personnel.
 - 2) Standard 17.5 - Elevator & Escalator Equipment (prohibition of
installing non-elevator equipment in Elevator Equipment Room /
Mechanical Penthouse).
- d. American Society of Testing Material (ASTM):
 - 1) D2301-04 - Standard Specification for Vinyl Chloride Plastic
Pressure Sensitive Electrical Insulating Tape.
- e. Building Industries Communications Services Installation (BICSI):
 - 1) All standards for smart building wiring, connections and
devices for commercial and medical facilities.
 - 2) Structured Building Cable Topologies.
 - 3) In consort with ANSI/EIA/TIA.
- f. Institute of Electrical and Electronics Engineers (IEEE):
 - 1) SO/TR 21730:2007 - Use of mobile wireless communication and
computing technology in healthcare facilities -
Recommendations for electromagnetic compatibility (management
of unintentional electromagnetic interference) with medical
devices.
 - 2) 0739-5175/08/©2008 IEEE - Medical Grade - Mission Critical -
Wireless Networks.
 - 3) C62.41 - Surge Voltages in Low-Voltage AC Power Circuits.
- g. NFPA:
 - 1) 70 - National Electrical Code (current date of issue) -
Articles 517, 645 & 800.
 - 2) 75 - Standard for Protection of Electronic Computer Data-
Processing Equipment.
 - 3) 77 - Recommended Practice on Static Electricity.
 - 4) 99 - Healthcare Facilities.
 - 5) 101 - Life Safety Code.
 - 6) 1600 - Disaster Management, Chapter 5.9 - Communications and
Warning
- 3. State Hospital Code(s).
- 4. Local Town, City and/or County Codes.

5. Accreditation Organization(s):

- a. Joint Commission on Accreditation of Hospitals Organization (JCAHO) – Section VI, Part 3a – Operating Features.

1.5 QUALIFICATIONS

- A. The OEM shall have had experience with three (3) or more installations of systems of comparable size and complexity with regards to type and design as specified herein. Each of these installations shall have performed satisfactorily for at least one (1) year after final acceptance by the user. Include the names, locations and point of contact for these installations as a part of the submittal.
- B. The Contractor shall submit certified documentation that they have been an authorized distributor and service organization for the OEM for a minimum of three (3) years. The Contractor shall be authorized by the OEM to pass thru the OEM's warranty of the installed equipment to VAMC. In addition, the OEM and Contractor shall accept complete responsibility for the design, installation, certification, operation, and physical support for the System. This documentation, along with the System Contractor and OEM certifications must be provided in writing as part of the Contractor's Technical submittal.
- C. The Contractor's Communications Technicians assigned to the System shall be fully trained, qualified, and certified by the OEM on the engineering, installation, operation, and testing of the System. The Contractor shall provide formal written evidence of current OEM certification(s) for the installer(s) as a part of the submittal or to the COR before being allowed to commence work on the System.
- D. The Contractor shall display all applicable national, state and local licenses.
- E. The Contractor shall submit copy (s) of Certificate of successful completion of OEM's installation/training school for installing technicians of the System's PA equipment being proposed.

1.6 CODES AND PERMITS

- A. Provide all necessary permits and schedule all inspections as identified in the contract's milestone chart, so that the system is proof of performance tested and ready for operation on a date directed by the Owner.
- B. The contractor is responsible to adhere to all codes described herein and associated contractual, state and local codes.

- C. The Contractor shall display all applicable national, state and local licenses and permits.

1.7 SCHEDULING

- A. After the award of contract, the Contractor shall prepare a detailed schedule (aka milestone chart) using "Microsoft Project" software or equivalent. The Contractor Project Schedule (CPS) shall indicate detailed activities for the projected life of the project. The CPS shall consist of detailed activities and their restraining relationships. It will also detail manpower usage throughout the project.
- B. It is the responsibility of the Contractor to coordinate all work with the other trades for scheduling, rough-in, and finishing all work specified. The Owner will not be liable for any additional costs due to missed dates or poor coordination of the supplying contractor with other trades.

1.8 REVIEW OF CONTRACT DRAWINGS AND EQUIPMENT DATA SUBMITTALS

(Note: The Contractor is encouraged, but not required, to submit separate technical submittal(s) outlining alternate technical approach(s) to the system requirements stated here-in as long as each alternate technical document(s) is complete, separate, and submitted in precisely the same manner as outlined herein. VAMC will review and rate each received alternate submittal, which follows this requirement, in exactly the same procedure as outlined herein. Partial, add-on, or addenda type alternates will not be accepted or reviewed.)

- A. Submit at one time within 10 days of contract award, drawings and product data on all proposed equipment and system. Check for compliance with contract documents and certify compliance with Contractor's "APPROVED" stamp and signature.
- B. Support all submittals with descriptive materials, i.e., catalog sheets, product data sheets, diagrams, and charts published by the manufacturer. These materials shall show conformance to specification and drawing requirements.
- C. Where multiple products are listed on a single cut-sheet, circle or highlight the one that you propose to use. Provide a complete and thorough equipment list of equipment expected to be installed in the system, with spares, as a part of the submittal. Special Communications (TVE-0050P3B) will not review any submittal that does not have this list.

- D. Provide four (4) copies to the PM for technical review. The PM will provide a copy to the offices identified in Paragraph 1.3.C & D, at a minimum for compliance review as described herein where each responsible individual(s) shall respond to the PM within 10 days of receipt of their acceptance or rejection of the submittal(s).
- E. Local amplifier and each interface distribution cabinet layout drawing, as they are expected to be installed.
- F. Equipment OEM technical literature detailing the electrical and technical characteristics of each item of equipment to be furnished.
- G. Engineering drawings of the System, showing calculated of expected signal levels at the headend input and output, each input and output distribution point, and signal level at each telecommunications outlet.

1.9 PROJECT RECORD DOCUMENTS (AS BUILTS)

- A. Throughout progress of the Work, maintain an accurate record of changes in Contract Documents. Upon completion of Work, transfer recorded changes to a set of Project Record Documents.
- B. The floor plans shall be marked in pen to include the following:
 - 1. All device locations with UL labels affixed.
 - 2. Conduit locations.
 - 3. Local equipment and specific location.
 - 4. Each interface and equipment specific location.
 - 5. Telecommunication Outlet (s -TCO) equipment and specific location
 - 6. TIP Wiring diagram(s).
 - 7. Warranty certificate.
 - 8. System test results.
 - 9. System Completion Document(s) or MOU.

1.10 WARRANTIES / GUARANTY

- A. The Contractor shall warrant the installation to be free from defect in material and workmanship for a period of two (2) years from the date of acceptance of the project by the Owner. The Contractor shall agree to remedy covered defects within four (4) hours of notification of major failures or within twenty-four (24) hours of notification for individual station related problems.
- B. The Contractor shall agree to grantee the system according to the guidelines outlined in Article 4 herein.

1.11 USE OF THE SITE

- A. Use of the site shall be at the GC's direction.
- B. Coordinate with the GC for lay-down areas for product storage and administration areas.
- C. Coordinate work with the GC and their sub-contractors.
- D. Access to buildings wherein the work is performed shall be directed by the GC.

1.12 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft.
- B. Store products in original containers.
- C. Coordinate with the GC for product storage. There may be little or no storage space available on site. Plan to potentially store materials off site.
- D. Do not install damaged products. Remove damaged products from the site and replaced with new product at no cost to the Owner.

1.13 PROJECT CLOSEOUT

- A. Prior to final inspection and acceptance of the work, remove all debris, rubbish, waste material, tools, construction equipment, machinery and surplus materials from the project site and thoroughly clean your work area.
- B. Before the project closeout date, the Contractor shall submit:
 - 1. Warranty certificate.
 - 2. Evidence of compliance with requirements of governing authorities such as the Low Voltage Certificate of Inspection.
 - 3. Project record documents.
 - 4. Instruction manuals and software that is a part of the system.
- C. Contractor shall submit written notice that:
 - 1. Contract Documents have been reviewed.
 - 2. Project has been inspected for compliance with contract.
 - 3. Work has been completed in accordance with the contract.

PART 2 - PRODUCTS / FUNCTIONAL REQUIREMENTS**2.0 GENERAL REQUIREMENTS FOR EQUIPMENT AND MATERIALS**

- A. Equipment: Active electronic type shall use solid-state components, fully rated for continuous duty unless otherwise indicated. Select equipment for normal operation on input power usually supplied between 110 to 130 VAC, 60 Hz.

- B. Meet all FCC requirements regarding low radiation and/or interference of RF signal(s). The system shall be designed to prevent direct pickup of signals from within and outside the building structure.
- C. Deliver a fully functioning and operable PA in the specific locations shown on the drawings.

2.1 SYSTEM DESCRIPTION

- A. Furnish and install a complete and fully functional and operable extension to the existing Public Address System.
- B. System hardware shall consist of a **standalone (separate)** PA communications network comprised of amplifiers, mixers, speakers, volume controls, test sets, equipment cabinets/racks, wiring and other options such as, sub zoning. The new local standalone system shall be interconnected to the existing Public address system and all new zones shall be operated and controlled from the existing main Public Address head-end. All necessary equipment required to meet the intent of these specifications, whether or not enumerated within these specifications, shall be supplied and installed to provide a complete and operating local Public Address System.
- C. The local PA Head Equipment shall be located in the local Telecommunications **Room**. The PA shall provide zoned, one-way voice paging and distributed music from the existing PA system through distributed, ceiling mounted loudspeakers. Voice input into the PA shall be by zone using the telephone system.
- D. The System shall utilize microprocessor components for all signaling and programming circuits and functions. Self contained or on board system program memory shall be non-volatile and protected from erasure from power outages for a minimum of 24 hours.
- E. The System shall allow voice pages to be made within a single zone, across programmed multiple zones or a global page (all zones) by using preset codes entered into the keypad of any telephone instrument attached to the PBX.
- F. The System shall interface with the Facility's existing PAS so that a global page (aka "all call" page) is communicated to the existing PAS and the new System of this project. Arrangements for interconnection of the System and the telephone system(s) shall be coordinated with the Owner and the PBX provider.

- G. All passive distribution equipment shall meet or exceed -80 dB radiation shielding (aka RFI) shielding specifications and be provided with screw type audio connectors.
- H. All equipment face plates utilized in the system shall be stainless steel, anodized aluminum or UL approved cycolac plastic for the areas where provided.
- I. All trunk, branch, and interconnecting cables and unused equipment ports or taps shall be terminated with proper terminating resistors designed for RF, audio and digital cable systems without adapters.
- J. Noise filters and surge protectors shall be provided for each equipment interface cabinet, headend cabinet, control console and local and remote amplifier locations to insure protection from input primary AC power surges and to insure noise glitches are not induced into low voltage data circuits.
- K. Plug-in connectors shall be provided to connect all equipment, except coaxial cables and RF transmission line interface points. Coaxial cable distribution points and RF transmission lines shall use coaxial cable connections recommended by the cable OEM and approved by the system OEM. Base band cable systems shall utilize barrier terminal screw type connectors, at a minimum. As an alternate, crimp type connectors installed with a ratchet type installation tool are acceptable provided the cable dress, pairs, shielding, grounding, connections and labeling are the same as the barrier terminal strip connectors. Tape of any type, wire nuts or solder type connections are unacceptable and will not be approved.
- L. Audio Level Processing: The control equipment shall consist of audio mixer(s), volume limiter(s) and/or compressor(s), and power amplifier(s) to process, adjust, equalize, isolate, filter, and amplify each audio channel for each sub-zone in the system and distribute them into the System's RF interfacing distribution trunks and amplification circuits. It is acceptable to use identified Telephone System cable pairs designated for Two-Way Radio interface and control use or identified as spare telephone cable pairs by the Facility's Telephone System Contractor. The use of telephone cable to distribute RF signals, carrying system or sub-system AC or DC voltage is not acceptable and will not be approved. Additionally, each control location shall be provided with the equipment required to insure the system can produce its designed audio channel capacity at each speaker identified on the

contract drawings. The Contractor shall provide: a spare set of telephone paging modules as recommended by the OEM (as a minimum provide one spare module for each installed module); one spare audio power amplifier, one spare audio mixer, one spare audio volume limiter and/or compressor, and one spare audio automatic gain adjusting device, and minimum RF equipment recommended by the OEM.

- M. Contractor is responsible for pricing all accessories and miscellaneous equipment required to form a complete and operating system. Unless otherwise noted in this Part, equipment quantities shall be as indicated on the drawings.

2.2 SYSTEM PERFORMANCE:

- A. At a minimum, each distribution, interconnection, interface, terminating point and TCO shall be capable of supporting the Facility's PA system voice service as follows:

1. Shall be compliant with and not degrade the operating parameters of the Public Switched Telephone Network (PSTN) and the Federal Telecommunications System (FTS) at each PSTN and FTS interface, interconnection and terminating locations in the TERs.
2. Audio Input: The signal level of each audio input channel at each input point shall be a MINIMUM of zero decibels measured (dBm), +0.10 dBm across 150 Ohms, balanced.
3. Audio Output: The audio signal level at each speaker shall be a MINIMUM of +0.25 Watt (W) and a maximum of +20 W, 600 Ohms balanced impedance, on a 70.7 V audio distribution line Contractor to determine and set each speaker's proper audio signal level (top) based on speaker location and the ambient noise level in speaker coverage area.
4. The system shall meet the following MINIMUM parameters at each speaker:
 - a. Cross Modulation: -46 dB
 - b. Hum Modulation: -55 dB
 - c. Isolation (outlet-outlet): 24 dB
 - d. Impedance:
 - 1) Distribution: 600 Ohm balanced @ 70.7 V audio line level.
 - 2) Speaker: Selectable, as required.
 - e. Audio Gain: 10 dB minimum @ mid-range measured with a sound pressure level meter (SPL)
 - f. Signal to noise (S/N) ratio: 35 dB, minimum

B. Audio Level Processing: The head-end equipment shall consist of audio mixer(s), volume limiter(s) and/or compressor(s), and power amplifier(s) to process, adjust, equalize, isolate, filter, and amplify each audio channel for each zone or sub-zone in the system and distribute them into the system's distribution trunks. It is acceptable to use identified telephone system cable pairs designated for PA use or identified as spare telephone cable pairs by the Facility's Telephone System Contractor.

1. THE USE OF TELEPHONE CABLE TO DISTRIBUTE PA SIGNALS CARRYING AC OR DC VOLTAGE IS NOT ACCEPTABLE AND WILL NOT BE APPROVED.
2. Additionally, each remote location shall be provided with the equipment required to ensure the system supervision and designed audio channel capacity at each speaker identified on the contract drawings.

2.3 MANUFACTURERS

- A. The products specified shall be new, FCC and UL Listed, labeled and produced by OEM of record. An OEM of record shall be defined as a company whose main occupation is the manufacture for sale of the items of equipment supplied and which:
1. Maintains a stock of replacement parts for the item submitted,
 2. Maintains engineering drawings, specifications, and operating manuals for the items submitted, and
 3. Has published and distributed descriptive literature and equipment specifications on the items of equipment submitted at least 30 days prior to the Invitation for Bid (IFB).
- B. Specifications contained herein as set forth in this document detail the salient operating and performance characteristics of equipment in order for VAMC to distinguish acceptable items of equipment from unacceptable items of equipment. When an item of equipment is offered or furnished for which there is a specification contained herein, the item of equipment offered or furnished shall meet or exceed the specification for that item of equipment.
- C. Equipment Standards and Testing:
1. The System has been defined herein as connected to systems identified as an Emergency performing Public Safety Support Functions. Therefore, at a minimum, the system shall conform to all aforementioned National and/or Local Public and Life Safety Codes

(which ever are the more stringent), NFPA, NEC, this specification, JCAHCO Life Safety Accreditation requirements, and the OEM recommendations, instructions, and guidelines.

2. All supplies and materials shall be listed, labeled or certified by UL or a nationally recognized testing laboratory (NRTL) where such standards have been established for the supplies, materials or equipment.
3. The provided equipment required by the System design and approved technical submittal must conform with each UL standard in effect for the equipment, as of the date of the technical submittal (or the date when the COR approved system equipment necessary to be replaced) was technically reviewed and approved by VAMC. Where a UL standard is in existence for equipment to be used in completion of this contract, the equipment must bear the approved UL seal.
4. Each item of electronic equipment to be provided under this contract must bear the approved UL seal or the seal of the testing laboratory that warrants the equipment has been tested in accordance with, and conforms to the specified standards. The placement of the UL Seal shall be a permanent part of the electronic equipment that is not capable of being transportable from one equipment item to another.

2.4 PRODUCTS

A. General.

1. Contractor is responsible for pricing all accessories and miscellaneous equipment required to form a complete and operating system. The equipment quantities provided herein shall be as indicated on the drawings with the exception of the indicated spare equipment.
2. Each cabinet shall be provided with internal and external items to maintain a neat and orderly system of equipment, wire, cable and conduit connections and routing.
3. Contractor Furnished Equipment List (CFEs):
 - a. The Contractor is required to provide a list of the CFE equipment to be furnished. The quantity, make and model number of each item is required. Select the required equipment items quantities that will satisfy the needs of the system as described herein and with the OEM's concurrence applied to the list(s), in writing.

- b. The following equipment items are the minimum requirements of VAMC to provide an acceptable system described herein:

<u>Item</u>	<u>Quantity</u>	<u>Unit</u>
1. Interface Panel(s)		
2. Equipment Back Box(s)		
3. Telephone Access Equipment		
4. AC Power Conditioner & Filter		
5. AC Power Strip		
6. Main Power Amplifiers		
7. Remote Power Amplifiers		
8. Interconnecting wire Cable(s)		
9. Wire Cable Connector(s)		
10. Wire Cable Terminator(s)		
11. Wire Management System		
12. Head End Function(s)		
13. Distribution System(s)		
14. Equipment Back Box(s)		
15. Speakers		
16. Local Volume Control(s)		

B. Refer to CFM Physical Security Manual (07-2007) for VAMC Facilities, Chapters 9.3 & 1) and PG 18-10, EDM, Chapters 7- Table 7-1, 8 & Appendix B, Telecommunications One Line Topology for specific Room and TIP Connection Requirements.

1. Interface Equipment:

a. TER:

1) Paging adaptor:

- a) The Contractor shall coordinate the installation of the paging adapter(s) designed for use with the Facility's telephone system.
- b) The Contractor shall provide and install a paging adapter(s) for each zone and sub zone. The paging adapter(s) shall be accessible by dialing a telephone number provided by the Facility's Telephone system administrator. The Paging Adapter shall:
 - 1) Monitor each audio input and output on the unit.
 - 2) Be provided with an electrical supervision panel to provide both audio and visual trouble alarms.
 - 3) Be provided as part of the head end equipment and shall be located in the Telephone Switch Room
 - 4) Be provided with Executive (aka emergency) Paging Override of all routine paging calls in progress or being accessed to allow system "all call" (aka global).

- 5) Be capable of internal time out capability.
 - 6) Function completely with the interface module.
 - 7) Provide one spare adapter.
- c) Time Out Device: A time out device/capability shall be provided to prevent system "hang-up" due to an off-hook telephone. The device shall be able to be preset from 30 seconds to two (2) minutes. Its function shall not interfere with or override the required "all call" (aka global) operational capability.
- 1) Central Processor Module:
 - 2) Controls system operations and holds all programmed parameters.
 - 3) Data link connection to additional CPU modules.
- d) Power Module: Provides 12V DC @ 800mA to Central Processor Module.
- e) Minimum three (3) Zone Module:
- 1) Provides a minimum of three (3) paging zone outputs at 70V audio sound level.
 - 2) Background Music inhibit switch for each zone.
- 2) Audio Monitor Panel:
- a) The panel shall be EIA/TIA standard for 483 mm (19") cabinet mounting.
 - b) It shall be provided in the upper portion of the head-end equipment cabinet.
 - c) Provide one (1) spare panel.
- 3) Amplifier Equipment:
- a) Paging (aka zone):
 - 1) Inputs for 600-ohm balanced telephone line, LO-Z balanced microphone, and background music.
 - 2) Input Sensitivity: Compatible with master stations and central equipment so amplifier delivers full rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on master stations speaker microphones, or handset transmitters
 - 3) Automatic Level Control (ALC) for pages, adjustable adjustable background music muting level during page, wall or rack mountable.

- 4) 16-ohm, 25V, 25V center tapped (CT), and 70V outputs.
Amplifier quantity and size (output power) as needed.
Continuous amplifier power rating shall exceed
loudspeaker load on amplifier by at least 25%.
- 5) Output Power: 70-V balanced line. 80 percent of the sum
of wattage settings of connected for each station and
speaker connected in all-call mode of operation, plus
an allowance for future stations.
- 6) Total Harmonic Distortion: Less than 5 percent at rated
output power with load equivalent to quantity of
stations connected in all-call mode of operation.
- 7) Minimum Signal-to-Noise Ratio: 45 dB, at rated output.
- 8) Frequency Response: Within plus or minus 3 dB from 70 to
12,000 Hz.
- b) Output Regulation: Maintains output level within 2 dB from
full to no load.
- c) Amplifier Protection: Prevents damage from shorted or open
output.
- d) Be provided with electronic supervision function(s).
- e) Provide one spare amplifier.
- 3) Provide the equipment in the nearest TER where the System is
installed to include the minimum equipment listed herein.
- 4) Equipment Cabinet: Comply with cabinet requirements as
aforementioned.
- 1. System Speakers:
 - a. Ceiling Cone-Type:
 - 1) Minimum Axial Sensitivity: 91 dB at one meter, with 1-W input.
 - 2) Frequency Response: Within plus or minus 3 dB from 70 to
15,000 Hz.
 - 3) Minimum Dispersion Angle: 100 degrees.
 - 4) Line Transformer: Maximum insertion loss of 0.5 dB, power
rating equal to speaker's, and at least four level taps.
 - 5) Enclosures: Steel housings or back boxes, acoustically
dampened, with front face of at least 0.0478-inch steel and
whole assembly rust proofed and factory primed; complete with
mounting assembly and suitable for surface ceiling, flush
ceiling, pendant or wall mounting; with relief of back
pressure.

- 6) Baffle: For flush speakers, minimum thickness of 0.032-inch aluminum with textured white finish. Completely fill the baffle with fiberglass.
 - 7) Vandal-Proof, High-Strength Baffle: For flush-mounted speakers, self-aging cast aluminum with tensile strength of 44,000 psi, 0.025-inch minimum thickness; countersunk heat-treated alloy mounting screws; and textured white epoxy finish.
 - 8) Size: 8 inches with 1-inch voice coil and minimum 5-oz. ceramic magnet.
 - 9) Have a minimum of two (2) safety wires installed to a solid surface or use a flexible conduit from ceiling / wall back box to the speaker back box.
 - 10) The speakers and mounting shall be self contained and wall mounted with flush back box at a minimum of 10 meter intervals and shall match (or contrast with, at the direction of the RE) the color of the adjacent surfaces.
 - 11) Provide one spare speaker, mount, and back box for each 50 speakers or portion thereof.
- b. System Cables: In addition to the TIP provided under Specification Section 27 15 00 - TIP Horizontal and Vertical Communications Cabling, provide the following additional TIP installation and testing requirements, provide the following minimum System TIP cables & interconnections:
- 1) Line Level Audio and Microphone Cable:
 - a) Line level audio and microphone cable for inside racks and conduit.
 - b) Shielded, twisted pair Minimum 22 American Wire Gauge (AWG), stranded conductors and 24 AWG drain wire with overall jacket.
 - 2) Speaker Level (Audio 70.7Volt [V]) Cable, Riser Rated:
 - a) For use with 70.7 V audio speaker circuits.
 - b) 18 AWG stranded pair, minimum.
 - c) UL-1333 listed.
 - 3) Speaker Level Audio Cable, Plenum Rated (70.7V):
 - a) For use with 70.7 V audio speaker circuits.
 - b) 18 AWG stranded pair, minimum.
 - 4) All cabling shall be riser and **plenum** rated.

- 5) Provide one (1) spare 1,000 foot roll of approved System (not microphone) cable only.

2. Raceways, Back Boxes and conduit:

a. Raceways:

- 1) In addition to the Raceways, Equipment Room Fittings provided under Specification Sections 27 15 00 TIP Communication Room Fittings and 27 15 00 - TIP Communications Horizontal and Vertical Cabling, provide the following additional TIP raceway and fittings:
- 2) Each raceway that is open top, shall be: UL certified for telecommunications systems, partitioned with metal partitions in order to comply with NEC Parts 517 & 800 to "mechanically separate telecommunications systems of different service, protect the installed cables from falling out when vertically mounted and allow junction boxes to be attached to the side to interface "drop" type conduit cable feeds.
- 3) Intercommunication System cable infrastructure: EMT or in J-hooks above accessible ceilings, 24 inches on center.
- 4) Junction boxes shall be not less than 2-1/2 inches deep and 6 inches wide by 6 inches long.
- 5) Flexible metal conduit is prohibited unless specifically approved by 0050P3B.

b. System Conduit:

- 1) The PA system is NFPA listed as Emergency / Public Safety Communication System which requires the entire system to be installed in a separate conduit system.
- 2) The use of centralized mechanically partitioned wireways may be used to augment main distribution conduit on a case by case basis when specifically approved by VAMC Headquarters (0050P3B).
- 3) Conduit Sleeves:
 - a) The AE has made a good effort to identify where conduit sleeves through full-height and fire rated walls on the drawings, and has instructed the electrician to provide the sleeves as shown on the drawings.

- b) While the sleeves shown on the drawings will be provided by others, the contractor is responsible for installing conduit sleeves and fire-proofing where necessary. It is often the case, that due to field conditions, the nurse-call cable may have to be installed through an alternate route. Any conduit sleeves required due to field conditions or those omitted by the engineer shall be provided by the cabling contractor.

3. Device Back Boxes:

- a. Furnish all back boxes required for the PA system devices.
- b. The PA contractor shall install the back boxes as well as the system conduit. Coordinate the delivery of the back boxes with the construction schedule.

4. Telecommunication Outlets (TCO): Populate each TCO that is required to perform system operations in the locations that were provided and cabled as a part of Specifications Sections 27 11 00 and 27 15 00. Provide additional TCO equipment, interfaces and connections as required by System design. Provide secured pathway(s) and TCOs as required.

F. Installation Kit:

1. General: The kit shall be provided that, at a minimum, includes all connectors and terminals, labeling systems, audio spade lugs, barrier strips, punch blocks or wire wrap terminals, heat shrink tubing, cable ties, solder, hangers, clamps, bolts, conduit, cable duct, and/or cable tray, etc., required to accomplish a neat and secure installation. All wires shall terminate in a spade lug and barrier strip, wire wrap terminal or punch block. Unfinished or unlabeled wire connections shall not be allowed. Turn over to the COR all unused and partially opened installation kit boxes, coaxial, fiberoptic, and twisted pair cable reels, conduit, cable tray, and/or cable duct bundles, wire rolls, physical installation hardware. The following are the minimum required installation sub-kits:

2. System Grounding:

- a. The grounding kit shall include all cable and installation hardware required. All radio equipment shall be connected to earth ground via internal building wiring, according to the NEC.

- b. This includes, but is not limited to:
 - 1) Coaxial Cable Shields.
 - 2) Control Cable Shields.
 - 3) Data Cable Shields.
 - 4) Equipment Racks.
 - 5) Equipment Cabinets.
 - 6) Conduits.
 - 7) Duct.
 - 8) Cable Trays.
 - 9) Power Panels.
 - 10) Connector Panels.
 - 11) Grounding Blocks.
- 3. Coaxial Cable: The coaxial cable kit shall include all coaxial connectors, cable tying straps, heat shrink tabbing, hangers, clamps, etc., required to accomplish a neat and secure installation.
- 4. Wire and Cable: The wire and cable kit shall include all connectors and terminals, audio spade lugs, barrier straps, punch blocks, wire wrap strips, heat shrink tubing, tie wraps, solder, hangers, clamps, labels etc., required to accomplish a neat and orderly installation.
- 5. Conduit, Cable Duct, and Cable Tray: The kit shall include all conduit, duct, trays, junction boxes, back boxes, cover plates, feed through nipples, hangers, clamps, other hardware required to accomplish a neat and secure conduit, cable duct, and/or cable tray installation in accordance with the NEC and this document.
- 6. Equipment Interface: The equipment kit shall include any item or quantity of equipment, cable, mounting hardware and materials needed to interface the systems with the identified sub-system(s) according to the OEM requirements and this document.
- 7. Labels: The labeling kit shall include any item or quantity of labels, tools, stencils, and materials needed to completely and correctly label each subsystem according to the OEM requirements, as-installed drawings, and this document.
- 8. Documentation: The documentation kit shall include any item or quantity of items, computer discs, as installed drawings, equipment, maintenance, and operation manuals, and OEM materials needed to completely and correctly provide the system documentation as required by this document and explained herein.

PART 3 - EXECUTION

3.1 PROJECT MANAGEMENT

- A. Assign a single project manager to this project who will serve as the point of contact for the Owner, the General Contractor, and the Engineer.
- B. The Contractor shall be proactive in scheduling work at the hospital, specifically the Contractor will initiate and maintain discussion with the general contractor regarding the schedule for ceiling cover up and install cables to meet that schedule.
- C. Contact the Office of Telecommunications, Special Communications Team (0050P3B) at (301) 734-0350 to have a VAMC Certified Telecommunications COR assigned to the project for telecommunications review, equipment and system approval and co-ordination with VAMC's Spectrum Management and OCIS Teams.

3.2 COORDINATION WITH OTHER TRADES

- A. Coordinate with the cabling contractor the location of the PA system faceplate and the faceplate opening for the PA system back boxes.
- B. Coordinate with the cabling contractor the location of TIP equipment.
- C. Before beginning work, verify the location, quantity, size and access for the following:
 - 1. Isolated ground AC power circuits provided for systems.
 - 2. Junction boxes, wall boxes, wire troughs, conduit stubs and other related infrastructure for the systems.
 - 3. System components installed by others.
 - 4. Overhead supports and rigging hardware installed by others.
- D. Immediately notify the Owner, GC and Consultant(s) in writing of any discrepancies

3.3 NEEDS ASSESSMENT

Provide a one-on-one meeting with the particular manager of each unit affected by the installation of the new PA system. Review the floor plan drawing, educate the nursing manager with the functions of the equipment that is being provided and gather details specific to the individual units; coverage and priorities of calls; staffing patterns; and other pertinent details that will affect system programming and training.

3.4 INSTALLATION

A. General

1. Execute work in accordance with National, State and local codes, regulations and ordinances.
2. Install work neatly, plumb and square and in a manner consistent with standard industry practice. Carefully protect work from dust, paint and moisture as dictated by site conditions. The Contractor will be fully responsible for protection of his work during the construction phase up until final acceptance by the Owner.
3. Install equipment according to OEM's recommendations. Provide any hardware, adaptors, brackets, rack mount kits or other accessories recommended by OEM for correct assembly and installation.
4. Secure equipment firmly in place, including receptacles, speakers, equipment racks, system cables, etc.
 - a. All supports, mounts, fasteners, attachments, and attachment points shall support their loads with a safety factor of at least 5:1.
 - b. Do not impose the weight of equipment or fixtures on supports provided for other trades or systems.
 - c. Any suspended equipment or associated hardware must be certified by the OEM for overhead suspension.
 - d. The Contractor is responsible for means and methods in the design, fabrication, installation and certification of any supports, mounts, fasteners and attachments.
5. Locate overhead ceiling-mounted loudspeakers as shown on drawings, with minor changes not to exceed 12" in any direction.
 - a. Mount transformers securely to speaker brackets or enclosures using screws. Adjust torsion springs as needed to securely support speaker assembly.
 - b. Speaker back boxes shall be completely filled with fiberglass insulation.
 - c. Seal cone speakers to their enclosures to prevent air passing from one side of the speaker to the other.
6. Finishes for any exposed work such as plates, racks, panels, speakers, etc. shall be approved by the Architect, Owner and 0050P3B.

7. Coordinate cover plates with field conditions. Size and install cover plates as necessary to hide joints between back boxes and surrounding wall. Where cover plates are not fitted with connectors, provide grommets in size and quantity required. Do not allow cable to leave or enter boxes without cover plates installed.
 8. Active electronic component equipment shall consist of solid state components, be rated for continuous duty service, comply with the requirements of FCC standards for telephone and data equipment, systems, and service.
 9. Color code all distribution wiring to conform to the PA Industry Standard, EIA/TIA, and this document, whichever is the more stringent. At a minimum, all equipment, cable duct and/or conduit, enclosures, wiring, terminals, and cables shall be clearly and permanently labeled according to and using the provided record drawings, to facilitate installation and maintenance.
 10. Connect the System's primary input AC power to the Facility' Critical Branch of the Emergency AC power distribution system as shown on the plans or if not shown on the plans consult with COR regarding a suitable circuit location prior to bidding.
 11. Product Delivery, Storage and Handling:
 - a. Delivery: Deliver materials to the job site in OEM's original unopened containers, clearly labeled with the OEM's name and equipment catalog numbers, model and serial identification numbers. The COR may inventory the cable, patch panels, and related equipment.
 - b. Storage and Handling: Store and protect equipment in a manner, which will preclude damage as directed by the COR.
 12. Where TCOs are installed adjacent to each other, install one outlet for each instrument.
 13. Equipment installed outdoors shall be weatherproof or installed in weatherproof enclosures with hinged doors and locks with two keys.
- B. Equipment Racks:
1. Fill unused equipment mounting spaces with blank panels or vent panels. Match color to equipment racks.
 2. Provide security covers for all devices not requiring routine operator control.

3. Provide vent panels and cooling fans as required for the operation of equipment within the OEM' specified temperature limits. Provide adequate ventilation space between equipment for cooling. Follow manufacturer's recommendations regarding ventilation space between amplifiers.
4. Provide insulated connections of the electrical raceway to equipment racks.
5. Provide continuous raceway/conduit with no more than 40% fill between wire troughs and equipment racks for all non-plenum-rated cable. Ensure each system is mechanically separated from each other in the wireway.
6. Ensure a minimum of 36 inches around each cabinet and/or rack to comply with OSHA Safety Standards. Cabinets and/or Racks installed side by side - the 36" rule applies to around the entire assembly

C. Distribution Frames.

1. A new stand-alone (i.e., self supporting, freestanding) PA rack/frame may be provided in each TR to interconnect the PA, TER, TCR, PCR, SCC, STRs & ECRs. Rack/frames shall be wired in accordance with industry standards and shall employ "latest state-of-the-art" modular cross-connect devices. The PA riser cable shall be sized to satisfy all voice/digital requirements plus not less than 50% spare (growth) capacity in each TR which includes a fiber optic backbone.
2. The frames/racks shall be connected to the TER/MCR system ground.

D. Wiring Practice - in addition to the MANDATORY infrastructure requirements outlined in VAMC Construction Specifications 27 10 00 - TIP Structured Communications Cabling, 27 11 00 - TIP Communications Rooms Fittings and 27 15 00 - TIP Horizontal and Vertical Communicators Cabling, the following additional practices shall be adhered too:

1. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway and Boxes for Electrical Systems."
2. Execute all wiring in strict adherence to the National Electrical Code, applicable local building codes and standard industry practices.
3. Wiring shall be classified according to the following low voltage signal types:
 - a. Balanced microphone level audio (below -20dBm) or Balanced line level audio (-20dBm to +30dBm)

- b. 70V audio speaker level audio.
 - c. Low voltage DC control or power (less than 48VDC)
4. Where raceway is to be EMT (conduit), wiring of differing classifications shall be run in separate conduit. Where raceway is to be an enclosure (rack, tray, wire trough, utility box) wiring of differing classifications which share the same enclosure shall be mechanically partitioned and separated by at least four (4) inches. Where Wiring of differing classifications must cross, they shall cross perpendicular to one another.
 5. Do not splice wiring anywhere along the entire length of the run. Make sure cables are fully insulated and shielded from each other and from the raceway for the entire length of the run.
 6. Do not pull wire through any enclosure where a change of raceway alignment or direction occurs. Do not bend wires to less than radius recommended by manufacturer.
 7. Replace the entire length of the run of any wire or cable that is damaged or abraded during installation. There are no acceptable methods of repairing damaged or abraded wiring.
 8. Use wire pulling lubricants and pulling tensions as recommended by the OEM.
 9. Use grommets around cut-outs and knock-outs where conduit or chase nipples are not installed.
 10. Do not use tape-based or glue-based cable anchors.
 11. Ground shields and drain wires to the Facility's signal ground system as indicated by the drawings.
 12. Field wiring entering equipment racks shall be terminated as follows:
 - a. Provide ample service loops at harness break-outs and at plates, panels and equipment. Loops should be sufficient to allow plates, panels and equipment to be removed for service and inspection.
 - b. Line level and speaker level wiring may be terminated inside the equipment rack using specified terminal blocks (see "Products.") Provide 15% spare terminals inside each rack. Microphone level wiring may only be terminated at the equipment served.
 - c. If specified terminal blocks are not designed for rack mounting, utilize ¾" plywood or 1/8" thick aluminum plates/blank panels as a mounting surface. Do not mount on the bottom of the rack.

- d. Employ permanent strain relief for any cable with an outside diameter of 1" or greater.
- 13. Use only balanced audio circuits unless noted otherwise
- 14. Make all connections as follows:
 - a. Make all connections using rosin-core solder or mechanical connectors appropriate to the application.
 - b. For crimp-type connections, use only tools that are specified by the manufacturer for the application.
 - c. Use only insulated spade lugs on screw terminals. Spade lugs shall be sized to fit the wire gauge. Do not exceed two lugs per terminal.
 - d. Wire nuts, electrical tape or "Scotch Lock" connections are not acceptable for any application.
- 15. Make all connections as follows:
 - a. Make all connections using rosin-core solder or mechanical connectors appropriate to the application.
 - b. For crimp-type connections, use only tools that are specified by the manufacturer for the application.
 - c. Use only insulated spade lugs on screw terminals. Spade lugs shall be sized to fit the wire gauge. Do not exceed two lugs per terminal.
 - d. Wire nuts, electrical tape or "Scotch Lock" connections are not acceptable for any application.
- 16. Noise filters and surge protectors shall be provided for each equipment interface cabinet, switch equipment cabinet, control console, local, and remote active equipment locations to ensure protection from input primary AC power surges and noise glitches are not induced into low Voltage data circuits.
- 17. Wires or cables **previously approved** to be installed outside of conduit, cable trays, wireways, cable duct, etc:
 - a. Only when specifically authorized as described herein, will wires or cables be identified and approved to be installed outside of conduit. The wire or cable runs shall be UL rated plenum and OEM certified for use in air plenums.
 - b. Wires and cables shall be hidden, protected, fastened and tied at 600 mm (24 in.) intervals, maximum, as described herein to building structure.

- c. Closer wire or cable fastening intervals may be required to prevents sagging, maintain clearance above suspended ceilings, remove unsightly wiring and cabling from view and discourage tampering and vandalism. Wire or cable runs, not provided in conduit, that penetrate outside building walls, supporting walls, and two hour fire barriers shall be sleeved and sealed with an approved fire retardant sealant.
 - d. Wire or cable runs to system components installed in walls (i.e.: volume attenuators, circuit controllers, signal, or data outlets, etc.) may, when specifically authorized by the RE, be fished through hollow spaces in walls and shall be certified for use in air plenum areas.
 - e. Completely test all of the cables after installation and replace any defective cables.
 - f. Wires or cables that are installed outside of buildings shall be in conduit, secured to solid building structures. If specifically approved, on a case by case basis, to be run outside of conduit, the wires or cables shall be installed, as described herein. The bundled wires or cables must: Be tied at not less than 460 mm (18 in.) intervals to a solid building structure; have ultra violet protection and be totally waterproof (including all connections). The laying of wires or cables directly on roof tops, ladders, drooping down walls, walkways, floors, etc. is not allowed and will not be approved.
- E. Cable Installation - In addition to the **MANDATORY** infrastructure requirements outlined in VAMC Construction Specifications 27 10 00 - Structured TIP Communications Cabling, 27 11 00 - TIP Communications Rooms and Fittings and 27 15 00 - TIP Communications Horizontal and Vertical Cabling and the following additional practices shall be adhered too:
- 1. Support cable on maximum 2'-0" centers. Acceptable means of cable support are cable tray, j-hooks, and bridal rings. Velcro wrap cable bundles loosely to the means of support with plenum rated Velcro straps. Plastic tie wraps are not acceptable as a means to bundle cables.
 - 2. Run cables parallel to walls.

3. Install maximum of 10 cables in a single row of J-hooks. Provide necessary rows of J-hooks as required by the number of cables.
4. Do not lay cables on top of light fixtures, ceiling tiles, mechanical equipment, or ductwork. Maintain at least 2'-0" clearance from all shielded electrical apparatus.
5. All cables shall be tested after the total installation is fully complete. All test results are to be documented. All cables shall pass acceptable test requirements and levels. Contractor shall remedy any cabling problems or defects in order to pass or comply with testing. This includes the re-pull of new cable as required at no additional cost to the Owner.
6. Ends of cables shall be properly terminated on both ends per industry and OEM's recommendations.
7. Provide proper temporary protection of cable after pulling is complete before final dressing and terminations are complete. Do not leave cable lying on floor. Bundle and tie wrap up off of the floor until you are ready to terminate.
8. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at outlets and terminals.
9. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.
10. Bundle, lace, and train conductors to terminal points without exceeding OEM's limitations on bending radii. Install lacing bars and distribution spools.
11. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used.
12. Cable shall not be run through structural members or be in contact with pipes, ducts, or other potentially damaging items.
13. Separation of Wires: (REFER TO RACEWAY INSTALLATION) Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches apart for speaker microphones and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.

14. Serve all cables as follows:

- a. Cover the end of the overall jacket with a 1" (minimum) length of transparent heat-shrink tubing. Cut unused insulated conductors 2" (minimum) past the heat-shrink, fold back over jacket and secure with cable-tie. Cut unused shield/drain wires 2" (minimum) past the Heatshrink and serve as indicated below.
- b. Cover shield/drain wires with heat-shrink tubing extending back to the overall jacket. Extend tubing ¼" past the end of unused wires, fold back over jacket and secure with cable tie.
- c. For each solder-type connection, cover the bare wire and solder connection with heat-shrink tubing.

F. Labeling: Provide labeling in accordance with ANSI/EIA/TIA-606-A. All lettering for PA circuits shall be stenciled using laser printers.

1. Cable and Wires (Hereinafter referred to as "Cable"): Cables shall be labeled at both ends in accordance with ANSI/EIA/TIA-606-A. Labels shall be permanent in contrasting colors. Cables shall be identified according to the System "Record Wiring Diagrams."
2. Equipment: System equipment shall be permanently labeled with contrasting plastic laminate or Bakelite material. System equipment shall be labeled on the face of the unit corresponding to its source.
 - a. Clearly, consistently, logically and permanently mark switches, connectors, jacks, relays, receptacles and electronic and other equipment.
 - b. Engrave and paint fill all receptacle panels using 1/8" (minimum) high lettering and contrasting paint.
 - c. For rack-mounted equipment, use engraved Lamacoid labels with white 1/8" (minimum) high lettering on black background. Label the front and back of all rack-mounted equipment.
3. Conduit, Cable Duct, and/or Cable Tray: The Contractor shall label all conduit, duct and tray, including utilized GFE, with permanent marking devices or spray painted stenciling a minimum of 3 meters (10 ft.) identifying it as the System. In addition, each enclosure shall be labeled according to this standard.
4. Termination Hardware: The Contractor shall label TCOs and patch panel connections using color coded labels with identifiers in accordance with ANSI/EIA/TIA-606-A and the "Record Wiring Diagrams."

5. Where multiple pieces of equipment reside in the same rack group, clearly and logically label each indicating to which room, channel, receptacle location, etc. they correspond.
 6. Permanently label cables at each end, including intra-rack connections. Labels shall be covered by the same, transparent heat-shrink tubing covering the end of the overall jacket. Alternatively, computer generated labels of the type which include a clear protective wrap may be used.
 7. Contractor's name shall appear no more than once on each continuous set of racks. The Contractor's name shall not appear on wall plates or portable equipment.
 8. Ensure each OEM supplied item of equipment has appropriate UL Labels Marks for the service the equipment is performed permanently attached or marked. SYSTEM EQUIPMENT INSTALLED NOT BEARING THESE UL MARKS WILL NOT BE ALLOWED TO BE A PART OF THE SYSTEM. THE CONTRACTOR SHALL BEAR ALL COSTS REQUIRED TO PROVIDE REPLACEMENT EQUIPMENT WITH APPROVED UL MARKS.
- G. Conduit and Signal Ducts: When the Contractor and/or OEM determines additional system conduits and/or signal ducts are required in order to meet the system minimum performance standards outlined herein, the contractor shall provide these items as follows:
1. Conduit:
 - a. The Contractor shall employ the latest installation practices and materials. The Contractor shall provide conduit, junction boxes, connectors, sleeves, weather heads, pitch pockets, and associated sealing materials not specifically identified in this document as GFE. Conduit penetrations of walls, ceilings, floors, interstitial space, fire barriers, etc., shall be sleeved and sealed.
 - b. All cables shall be installed in separate conduit and/or signal ducts (exception from the separate conduit requirement to allow PA cables to be installed in partitioned cable tray with voice cables may be granted in writing by the COR if requested). Conduits shall be provided in accordance with Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS, and NEC Articles 517 for Critical Care and 800 for Communications systems, at a minimum.

- c. When metal, plastic covered, etc., flexible cable protective armor or systems are specifically authorized to be provided for use in the System, their installation guidelines and standards shall be as specified herein, Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS, and the NEC.
 - d. When "interduct" flexible cable protective systems is specifically authorized to be provided for use in the System, its installation guidelines and standards shall be as the specified herein, Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS, and the NEC.
 - e. Conduit fill (including GFE approved to be used in the system) shall not exceed 40%. Each conduit end shall be equipped with a protective insulator or sleeve to cover the conduit end, connection nut or clamp, to protect the wire or cable during installation and remaining in the conduit. Electrical power conduit shall be installed in accordance with the NEC. AC power conduit shall be run separate from signal conduit.
 - f. Ensure that Critical Care PA Systems (as identified by NEC Section 517) are completely separated and protected from all other systems.
2. Signal Duct, Cable Duct, or Cable Tray:
- a. The Contractor shall use GFE signal duct, cable duct, and/or cable tray, when identified and approved by the COR.
 - b. Approved signal and/or cable duct shall be a minimum size of 100 mm x 100 mm (4 in. X 4 in.) inside diameter with removable tops or sides, as appropriate. Protective sleeves, guides or barriers are required on all sharp corners, openings, anchors, bolts or screw ends, junction, interface and connection points.
 - c. Approved cable tray shall be fully covered, mechanically and physically partitioned for multiple electronic circuit use, and be UL certified and labeled for use with telecommunication circuits and/or systems. The COR shall approve width and height dimensions.
 - d. All cable junctions and taps shall be accessible. Provide an 8" X 8" X 4" (minimum) junction box attached to the cable duct or raceway for installation of distribution system passive equipment. Ensure all equipment and tap junctions are accessible

3.5 PROTECTION OF NETWORK DEVICES

Contractor shall protect network devices during unpacking and installation by wearing manufacturer approved electrostatic discharge (ESD) wrist straps tied to chassis ground. The wrist strap shall meet OSHA requirements for prevention of electrical shock, should technician come in contact with high voltage.

3.6 CUTTING, CLEANING AND PATCHING

- A. It shall be the responsibility of the contractor to keep their work area clear of debris and clean area daily at completion of work.
- B. It shall be the responsibility of the contractor to patch and paint any wall or surface that has been disturbed by the execution of this work.
- C. The Contractor shall be responsible for providing any additional cutting, drilling, fitting or patching required that is not indicated as provided by others to complete the Work or to make its parts fit together properly.
- D. The Contractor shall not damage or endanger a portion of the Work or fully or partially completed construction of the Owner or separate contractors by cutting, patching or otherwise altering such construction, or by excavation. The Contractor shall not cut or otherwise alter such construction by the Owner or a separate contractor except with written consent of the Owner and of such separate contractor; such consent shall not be unreasonably withheld. The Contractor shall not unreasonably withhold from the Owner or a separate Contractor the Contractor's consent to cutting or otherwise altering the Work.
- E. Where coring of existing (previously installed) concrete is specified or required, including coring indicated under unit prices, the location of such coring shall be clearly identified in the field and the location shall be approved by the Project Manager prior to commencement of coring work.

3.7 FIREPROOFING

- A. Where PA wires, cables and conduit penetrate fire rated walls, floors and ceilings, fireproof the opening.
- B. Provide conduit sleeves (if not already provided by electrical contractor) for cables that penetrate fire-rated walls and Telecommunications Rooms floors and ceilings. After the cabling

installation is complete, install fire proofing material in and around all conduit sleeves and openings. Install fire proofing material thoroughly and neatly. Seal all floor and ceiling penetrations.

- C. Use only materials and methods that preserve the integrity of the fire stopping system and its rating.
- D. Install fireproofing where low voltage cables are installed in the same manholes with high voltage cables; also cover the low voltage cables with arc proof and fireproof tape.
- E. Use approved fireproofing tape of the same type as used for the high voltage cables, and apply the tape in a single layer, one-half lapped or as recommended by the manufacturer. Install the tape with the coated side towards the cable and extend it not less than 25 mm (one inch) into each duct.
- F. Secure the tape in place by a random wrap of glass cloth tape.

3.8 GROUNDING

- A. Ground PA cable shields and equipment to eliminate shock hazard and to minimize ground loops, commonmode returns, noise pickup, cross talk, and other impairments as specified in CFM Division 27, Section 27 05 26 - Grounding and Bonding for Communications Systems.
- B. Facility Signal Ground Terminal: Locate at main room or area signal ground within the room (i.e. head end and telecommunications rooms) or area(s) and indicate each signal ground location on the drawings.
- C. Extend the signal ground to inside each equipment cabinet and/or rack. Ensure each cabinet and/or rack installed item of equipment is connected to the extended signal ground. Isolate the signal ground from power and major equipment grounding systems.
- D. When required, install grounding electrodes as specified in CFM Division 26, Section 26 05 26 -Grounding and Bonding for Electrical Systems.
- E. Do not use "3rd or 4th" wire internal electrical system conductors for communications signal ground.
- F. Do not connect the signal ground to the building's external lightning protection system.
- G. Do Not "mix grounds" of different systems.
- H. Insure grounds of different systems are installed as to not violate OSHA Safety and NEC installation requirements for protection of personnel.

PART 4 - TESTING / GUARANTY / TRAINING**4.0 SYSTEM LISTING**

The PA System is NFPA listed as an "Emergency / Public Safety" Communications system. The following testing and guaranty provisions are the minimum to be performed and provided by the contractor and OEM.

4.1 PROOF OF PERFORMANCE TESTING**A. Intermediate Testing:**

1. After completion of 25 - 30% the installation of a head end cabinet(s) and equipment, one microphone console, local and remote enunciation stations, two (2) zones, two (2) sub zones prior to any further work, this portion of the system must be pretested, inspected, and certified. Each item of installed equipment shall be checked to ensure appropriate UL Listing and Certification Labels are affixed as required by NFPA -Life Safety Code 101-3.2 (a) & (b) and JCHCO evaluation guidelines, and proper installation practices are followed. The intermediate test shall include a full operational test.
2. All inspections and tests shall be conducted by an OEM-certified contractor representative and witnessed by TVE-0050P3B if there is no local Government Representative that processes OEM and VAMC approved Credentials to inspect and certify the system. The results of the inspection will be officially recorded by the Government Representative and maintained on file by the RE, until completion of the entire project. The results will be compared to the Acceptance Test results. An identical inspection may be conducted between the 65 - 75% of the system construction phase, at the direction of the COR.

B. Pretesting:

1. Upon completing installation of the PA System, the Contractor shall align, balance, and completely pretest the entire system under full operating conditions.
2. Pretesting Procedure:
 - a. During the System Pretest the Contractor shall verify (utilizing approved test equipment) that the System is fully operational and meets all the System performance requirements of this standard.

- b. The Contractor shall pretest and verify that all PA System functions and specification requirements are met and operational, no unwanted aural effects, such as signal distortion, noise pulses, glitches, audio hum, poling noise, etc. are present. At a minimum, each of the following locations shall be fully pretested:
 - 1) Central Control Cabinets.
 - 2) Local Control Stations.
 - 3) Zone Equipment/Systems.
 - 4) Sub-Zone Equipment/Systems.
 - 5) Remote Control Panels.
 - a.)TCR.
 - b.)PCR/SCC.
 - c.)ECR.
 - 6) All Networked locations.
 - 7) System interface locations (i.e., TELCO, two way radio, etc.).
 - 8) System trouble reporting.
 - 3. The Contractor shall provide four (4) copies of the recorded system pretest measurements and the written certification that the System is ready for the formal acceptance test shall be submitted to the COR.
- C. Acceptance Test:
- 1. After the PA System has been pretested and the Contractor has submitted the pretest results and certification to the COR, then the Contractor shall schedule an acceptance test date and give the COR 30 day's written notice prior to the date the acceptance test is expected to begin. The System shall be tested in the presence of TVE 0050P3B and an OEM certified representatives. The System shall be tested utilizing the approved test equipment to certify proof of performance and Emergency / Public Safety compliance. The tests shall verify that the total System meets all the requirements of this specification. The notification of the acceptance test shall include the expected length (in time) of the test.

2. The acceptance test shall be performed on a "go-no-go" basis. Only those operator adjustments required to show proof of performance shall be allowed. The test shall demonstrate and verify that the installed System does comply with all requirements of this specification under operating conditions. The System shall be rated as either acceptable or unacceptable at the conclusion of the test. Failure of any part of the System that precludes completion of system testing, and which cannot be repaired in four (4) hours, shall be cause for terminating the acceptance test of the System. Repeated failures that result in a cumulative time of eight (8) hours to affect repairs shall cause the entire System to be declared unacceptable. Retesting of the entire System shall be rescheduled at the convenience of the Government.
3. Retesting of the entire System shall be rescheduled at the convenience of the Government and costs borne by the Contractor at the direction of the SRE.

D. Acceptance Test Procedure:

1. Physical and Mechanical Inspection:

- a. The TVE 0050P3B Representative will tour all areas where the PA system and all sub-systems are completely and properly installed to insure they are operationally ready for proof of performance testing. A system inventory including available spare parts will be taken at this time. Each item of installed equipment shall be checked to ensure appropriate UL certification labels are affixed.
- b. The System diagrams, record drawings, equipment manuals, TIP Auto CAD Disks, intermediate, and pretest results shall be formally inventoried and reviewed.
- c. Failure of the System to meet the installation requirements of this specification shall be grounds for terminating all testing.

2. Operational Test:

- a. After the Physical and Mechanical Inspection, the system head end equipment shall be checked to verify that it meets all performance requirements outlined herein. A spectrum analyzer and sound level meter may be utilized to accomplish this requirement.

- b. Following the head end equipment test, each speaker (or on board speaker) shall be inspected to ensure there are no signal distortions such as intermodulation, data noise, popping sounds, erratic system functions, on any function.
 - c. The distribution system shall be checked at each interface, junction, and distribution point, first, middle, and last speaker in each leg to verify the PA distribution system meets all system performance standards.
 - d. If the RED system is a part of the system, each volume stepper switches shall be checked to insure proper operation of the pillow speaker, the volume stepper and the RED system (if installed).
 - e. Additionally, each installed head end equipment, microphone console; amplifier, mixer, distributed speaker/amplifier, monitor speaker, telephone interface, power supply and remote amplifiers shall be checked insuring they meet the requirements of this specification.
 - f. Once these tests have been completed, each installed sub-system function shall be tested as a unified, functioning and fully operating system. The typical functions are: "all call," three sub-zoned, minimum of 15 minutes of UPS operation, electrical supervision, trouble panel, corridor speakers and audio paging.
 - g. Individual Item Test: The TVE 0050P3B Representative will select individual items of equipment for detailed proof of performance testing until 100% of the System has been tested and found to meet the contents of this specification. Each item shall meet or exceed the minimum requirements of this document.
3. Test Conclusion:
- a. At the conclusion of the Acceptance Test, using the generated punch list (or discrepancy list) the VAMC and the Contractor shall jointly agree to the results of the test, and reschedule testing on deficiencies and shortages with the COR. Any retesting to comply with these specifications will be done at the Contractor's expense.
 - b. If the System is declared unacceptable without conditions, all rescheduled testing expenses will be borne by the Contractor.

E. Acceptable Test Equipment: The test equipment shall be furnished by the Contractor shall have a calibration tag of an acceptable calibration service dated not more than 12 months prior to the test. As part of the submittal, a test equipment list shall be furnished that includes the make and model number of the following type of equipment as a minimum:

1. Spectrum Analyzer.
2. Signal Level Meter.
3. Volt-Ohm Meter.
4. Sound Pressure Level (SPL) Meter.
5. Oscilloscope.
6. Random Noise Generator.
7. Audio Amplifier with External Speaker.

4.2 SYSTEM WARRANTY PERIOD OF SERVICE

A. Contractor's Responsibility:

1. The Contractor shall ensure that all provided material and equipment will be free from defects, workmanship and will remain so for a period of two (2) years from date of final acceptance of the System by the VAMC. The Contractor shall provide OEM's equipment warranty documents, to the Facility Contracting Officer's Technical Representative (COR) if the Facility has taken possession of the building), that certifies each item of equipment installed conforms to OEM published specifications.
2. The Contractor's maintenance personnel shall have the ability to contact the Contractor and OEM for emergency maintenance and logistic assistance, remote diagnostic testing, and assistance in resolving technical problems at any time. This contact capability shall be provided by the Contractor and OEM at no additional cost to the VAMC.
3. All Contractor maintenance and supervisor personnel shall be fully qualified by the OEM and must provide two (2) copies of current and qualified OEM training certificates and OEM certification upon request.
4. Additionally, the Contractor shall accomplish the following minimum requirements during the two year Warranty period:
 - a. Response Time During the **Two Year** Warranty Period:

- 1) The Facility Contracting Officer's Technical Representative (COR) if the system has been turned over to the Facility) is the Contractor's ONLY OFFICIAL reporting and contact official during the guaranty period.
 - 2) A standard work week is considered 8:00 A.M. to 5:00 P.M. or as designated by the Facility Contracting Officer's Technical Representative (COR), Monday through Friday exclusive of Federal Holidays.
 - a) An emergency trouble call within eight (8) hours of its report. An emergency trouble is considered a trouble which causes a sub-zone, zone, distribution point, terminal cabinet, or all call system to be inoperable at anytime.
 - 3) Preventive maintenance procedure(s) shall be performed by the Contractor in accordance with the OEM's recommended practice and service intervals during non-busy time agreed to by the Facility Contracting Officer's technical Representative (COR) and Contractor.
- B. Work Not Included: Maintenance and repair service shall not include the performance of any work due to improper use; accidents; other vendor, contractor, or Owner tampering or negligence, for which the Contractor is not directly responsible and does not control. The Contractor shall immediately notify the Facility Contracting Officer's Technical Representative (COR) in writing upon the discovery of these incidents. The Facility Contracting Officer's Technical Representative (COR) will investigate all reported incidents and render an official opinion in writing concerning the supplied information.

4.3 TRAINING

- A. Provide the following minimum training times and durations:
 1. 48 hours prior to opening for BME / Electronic Staff (in 8-hour increments) - split evenly over 3 weeks and day and night shifts. Coordinate schedule with Owner.
 2. 24 hours for supervisors and system administrators.

- - - E N D - - -

SECTION 27 52 23
NURSE CALL AND CODE BLUE SYSTEMS

PART 1 - GENERAL

1.1 SECTION SUMMARY

- A. Work covered by this document includes design, engineering, labor, material and products, equipment warranty, for, and incidental to, the extension and installation of an existing operational National Fire Protection Association (NFPA) - Life Safety Code 101.3-2 (a) Labeled and (b) Listed, Emergency Service Nurse-Call and/or Life Safety listed Code Blue Communication System and associated equipment (here-in-after referred to as the System) provided in approved locations indicated on the contract drawings. These items shall be tested and certified capable of receiving, distributing, interconnecting and supporting Nurse-Call and/or Code Blue communications signals generated local and remotely as detailed herein.
- B. Work shall be complete, Occupational Safety and Health Administration (OSHA), National Recognized Testing Laboratory (NRTL - i.e., Underwriters Laboratory [UL]) Listed and Labeled; and VAMC Central Office (VACO), Telecommunications Voice Engineering (TVE 0050P3B) tested, certified and ready for operation.
- C. The equipment and devices shall be delivered free of engineering, manufacturing, installation, and functional defects. It shall be designed, engineered and installed for ease of operation, maintenance, and testing.
- D. The term "provide", as used herein, shall be defined as: designed, engineered, furnished, installed, certified, tested, and guaranteed by the Contractor.
- E. Specification Order of Precedence: In the event of a conflict between the text of this document and the Project's Contract Drawings outlined and/or cited herein; THE TEXT OF THIS DOCUMENT TAKES PRECEDENCE.
HOWEVER, NOTHING IN THIS DOCUMENT WILL SUPERSEDE APPLICABLE EMERGENCY LAWS AND REGULATIONS, SPECIFICALLY NATIONAL AND/OR LOCAL LIFE AND PUBLIC SAFETY CODES. The Local Fire Marshall and/or VAMC Public Safety Officer are the only authorities that may modify this document's EMERGENCY CODE COMPLIANCE REQUIREMENTS, on a case by case basis, in writing and confirmed by VAMC's Contracting Officer Technical Representative (COR) and TVE-0050P3B. The VA COR is the only approving authority for other amendments to this document that may be granted, on

a case by case basis, in writhing with technical concurrencies by VAMC's COR, TVE-0050P3B and identified Facility Project Personnel.

1. The Contracting Officer is the only Government official with the authority to legally modify the contract with respect to any changes in the contract requirements.

- F. The Original Equipment Manufacturer (OEM) and Contractor shall ensure that all management, sales, engineering and installation personnel have read and understand the requirements of this specification before the equipment and devices is designed, engineered, delivered and provided. The Contractor shall furnish a written statement stating this requirement as a part of the technical submittal that includes each name and certification, including the OEMs. The Contractor is cautioned to obtain any approvals for system changes relating to the published contract specifications and drawings, and shall be obtained in writing from only the Contracting Officer before proceeding with the change.

1.2 RELATED SECTIONS

- A. 01 33 23 - Shop Drawings, Product Data and Samples.
- B. 07 84 00 - Firestopping.
- C. 01 00 00 - General Requirements.
- D. 26 05 21 - Low - Voltage Electrical Power Conductors and Cables (600 Volts and Below).
- E. 27 05 11 - Requirements for Communications Installations.
- F. 27 05 26 - Grounding and Bonding for Communications Systems.
- G. 27 05 33 - Raceways and Boxes for Communications Systems.
- H. 27 10 00 - TIP Structured Communications Systems Cabling.
- I. 27 11 00 - TIP Communications Interface and Equipment Rooms Fittings.
- J. 27 15 00 - TIP Communications Horizontal and Vertical Cabling.
- K. 27 41 41 - Master Antenna Television Equipment and Systems and/or Extension.

1.3 DEFINITION

- A. Provide: Design, engineer, furnish, install, connect complete, test, certify and guarantee.
- B. Work: Materials furnished and completely installed.
- C. Review of contract drawings: A service by the engineer to reduce the possibility of materials being ordered which do not comply with contract documents. The engineer's review shall not relieve the Contractor of responsibility for dimensions or compliance with the

contract documents. The reviewer's failure to detect an error does not constitute permission for the Contractor to proceed in error.

- D. Headquarters (aka VACO) Technical Review, for National and VAMC Communications and Security, Codes, Frequency Licensing Standards, Guidelines and Compliance:

Office of Telecommunications
 Special Communications Team (0050P3B)
 1335 East West Highway - 3rd Floor
 Silver Spring, Maryland 20910,
 (O) 301-734-0350, (F) 301-734-0360

- E. Contractor: Successful bidder.

1.4 REFERENCES

- A. The installation shall comply fully with all governing authorities, laws and ordinances, regulations, codes and standards, including, but not limited to:

1. United States Federal Law:

- a. Departments of:

- 1) Commerce, Consolidated Federal Regulations (CFR), Title 15 - Under the Information Technology Management Reform Act (Public Law 104-106), the Secretary of Commerce approves standards and guidelines that are developed by the:

- a) Chapter II, National Institute of Standards Technology (NIST - formerly the National Bureau of Standards). Under Section 5131 of the Information Technology Management Reform Act of 1996 and the Federal Information Security Management Act of 2002 (Public Law 107-347), NIST develops - Federal Information Processing Standards Publication (FIPS) 140-2-Security Requirements for Cryptographic Modules.

- b) Chapter XXIII, National Telecommunications and Information Administration (NTIA - aka 'Red Book') Chapter 7.8 / 9; CFR, Title 47 Federal communications Commission (FCC) Part 15, Radio Frequency Restriction of Use and Compliance in "Safety of Life" Functions & Locations.

- 2) FCC - Communications Act of 1934, as amended, CFR, Title 47 - Telecommunications, in addition to Part 15 - Restrictions of use for Part 15 listed Radio Equipment in Safety of Life / Emergency Functions / Equipment/ Locations (also see CFR,

Title 15 - Department of Commerce, Chapter XXIII - NTIA):

- a) Part 15 - Restrictions of use for Part 15 listed Radio Equipment in Safety of Life / Emergency Functions / Equipment/Locations.
 - b) Part 58 - Television Broadcast Service.
 - c) Part 90 - Rules and Regulations, Appendix C.
- 3) Health, (Public Law 96-88), CFR, Title 42, Chapter IV Health & Human Services, CFR, Title 46, Subpart 1395(a)(b) JCAHO "a hospital that meets JCAHO accreditation is deemed to meet the Medicare conditions of Participation by meeting Federal Directives:"
- a) All guidelines for Life, Personal and Public Safety; and, Essential and Emergency Communications.
- 4) Labor, CFR, Title 29, Part 1910, Chapter XVII - Occupational Safety and Health Administration (OSHA), Occupational Safety and Health Standard:
- a) Subpart 7 - Definition and requirements (for a NRTL - 15 Laboratory's, for complete list, contact (http://www.osha.gov/dts/otpc/nrtl/faq_nrtl.html)):
 - 1) UL:
 - a) 44-02 - Standard for Thermoset-Insulated Wires and Cables.
 - b) 65 - Standard for Wired Cabinets.
 - c) 83-03 - Standard for Thermoplastic-Insulated Wires and Cables.
 - d) 467-01 - Standard for Electrical Grounding and Bonding Equipment
 - e) 468 - Standard for Grounding and Bonding Equipment.
 - f) 486A-01 - Standard for Wire Connectors and Soldering Lugs for Use with Copper Conductors
 - g) 486C-02 - Standard for Splicing Wire Connectors.
 - h) 486D-02 - Standard for Insulated Wire Connector Systems for Underground Use or in Damp or Wet Locations.
 - i) 486E-00 - Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors.
 - j) 493-01 - Standard for Thermoplastic-Insulated Underground Feeder and Branch Circuit Cable.

- k) 514B-02 - Standard for Fittings for Cable and Conduit.
- l) 1069 - Hospital Signaling and Nurse Call Equipment.
- m) 1449 - Standard for Transient Voltage Surge Suppressors.
- n) 1479-03 - Standard for Fire Tests of Through-Penetration Fire Stops.
- o) 1666 - Standard for Wire/Cable Vertical (Riser) Tray Flame Tests.
- p) 1863 - Standard for Safety, Communications Circuits Accessories.
- q) 2024 - Standard for Optical Fiber Raceways.
- r) 60950-1/2 - Information Technology Equipment - Safety.
- 2) Canadian Standards Association (CSA): same tests as for UL.
- 3) Communications Certifications Laboratory (CCL): same tests As for UL.
- 4) Intertek Testing Services NA, Inc. (ITSNA formerly Edison Testing Laboratory [ETL]): same tests as for UL.
- b) Subpart 35 - Compliance with NFPA 101 - Life Safety Code.
- c) Subpart 36 - Design and construction requirements for exit routes.
- d) Subpart 268 - Telecommunications.
- e) Subpart 305 - Wiring methods, components, and equipment for general use.
- 5) Department of Transportation, CFR, Title 49 (Public Law 89-670), Part 1, Subpart C - Federal Aviation Administration (FAA):
 - a) Standards AC 110/460-ID & AC 707 / 460-2E - Advisory Circulars for Construction of Antenna Towers.
 - b) Forms 7450 and 7460-2 - Antenna Construction Registration.
- 6) Veterans Affairs (Public Law No. 100-527), CFR, Title 38, Volumes I & II:
 - a) Office of Telecommunications:
 - 1) Handbook 6100 - Telecommunications.
 - a) Spectrum Management FCC & NTIA Radio Frequency Compliance and Licensing Program.

- b) Special Communications Proof of Performance Testing, VACO Compliance and Life Safety Certification(s).
 - b) Office of Cyber and Information Security (OCIS):
 - 1) Handbook 6500 - Information Security Program.
 - 2) Wireless and Handheld Device Security Guideline Version 3.2, August 15, 2005.
 - c) VAMC's National Center for Patient Safety - Veterans Health Administration Warning System, Failure of Medical Alarm Systems using Paging Technology to Notify Clinical Staff, July 2004.
 - d) VAMC's Center for Engineering Occupational Safety and Health, concurrence with warning identified in VAMC Directive 7700.
 - e) Office of Construction and Facilities Management (CFM):
 - 1) Master Construction Specifications (PG-18-1).
 - 2) Standard Detail and CAD Standards (PG-18-4).
 - 3) Equipment Guide List (PG-18-5).
 - 4) Electrical Design Manual for VAMC Facilities (PG 18-10), Articles 7 & 8.
 - 5) Minimum Requirements of A/E Submissions (PG 18-15):
 - a) Volume B, Major New Facilities, Major Additions; and Major Renovations, Article VI, Paragraph B.
 - b) Volume C - Minor and NRM Projects, Article III, Paragraph S.
 - c) Volume E - Request for Proposals Design/Build Projects, Article II, Paragraph F.
 - 6) Mission Critical Facilities Design Manual (Final Draft - 2007).
 - 7) Life Safety Protected Design Manual (Final Draft - 2007).
 - 8) Solicitation for Offerors (SFO) for Lease Based Clinics - (05-2009).
 - b. Federal Specifications (Fed. Specs.):
 - 1) A-A-59544-00 - Cable and Wire, Electrical (Power, Fixed Installation).
- 2. National Codes:
 - a. American Institute of Architects (AIA): Guidelines for Healthcare Facilities.

- b. American National Standards Institute/Electronic Industries Association/Telecommunications Industry Association (ANSI/EIA/TIA):
 - 1) 568-B - Commercial Building Telecommunications Wiring Standards:
 - a) B-1 - General Requirements.
 - b) B-2 - Balanced twisted-pair cable systems.
 - c) B-3 - Fiber optic cable systems.
 - 2) 569 - Commercial Building Standard for Telecommunications Pathways and Spaces.
 - 3) 606 - Administration Standard for the Telecommunications Infrastructure of Communications Buildings.
 - 4) 607 - Commercial Building Grounding and Bonding Requirements for Telecommunications.
 - 5) REC 127-49 - Power Supplies.
 - 6) RS 270 - Tools, Crimping, Solderless Wiring Devices, Recommended Procedures for User Certification.
- c. American Society of Mechanical Engineers (ASME):
 - 1) Standard 17.4 - Guide for Emergency Personnel.
 - 2) Standard 17.5 - Elevator & Escalator Equipment (prohibition of installing non-elevator equipment in Elevator Equipment Room / Mechanical Penthouse).
- d. American Society of Testing Material (ASTM):
 - 1) D2301-04 - Standard Specification for Vinyl Chloride Plastic Pressure Sensitive Electrical Insulating Tape.
- e. Building Industries Communications Services Installation (BICSI):
 - 1) All standards for smart building wiring, connections and devices for commercial and medical facilities.
 - 2) Structured Building Cable Topologies.
 - 3) In consort with ANSI/EIA/TIA.
- f. Institute of Electrical and Electronics Engineers (IEEE):
 - 1) SO/TR 21730:2007 - Use of mobile wireless communication and computing technology in healthcare facilities - Recommendations for electromagnetic compatibility (management of unintentional electromagnetic interference) with medical devices.
 - 2) 0739-5175/08/@2008 IEEE - Medical Grade - Mission Critical - Wireless Networks.

3) C62.41 - Surge Voltages in Low-Voltage AC Power Circuits.

g. NFPA:

1) 70-2011 - National Electrical Code - Articles 517, 645 & 800.

2) 75 - Standard for Protection of Electronic Computer Data-Processing Equipment.

3) 77 - Recommended Practice on Static Electricity.

4) 99 - Healthcare Facilities.

5) 101 - Life Safety Code.

3. State Hospital Code(s).

4. Local Town, City and/or County Codes.

5. Accreditation Organization(s):

a. Joint Commission on Accreditation of Hospitals Organization
(JCAHO) - Section VI, Part 3a - Operating Features.

1.5 QUALIFICATIONS

- A. The OEM shall have had experience with three (3) or more installations of Nurse Call systems of comparable size and interfacing complexity with regards to type and design as specified herein. Each of these installations shall have performed satisfactorily for at least one (1) year after final acceptance by the user. Include the names, locations and point of contact for these installations as a part of the submittal.
- B. The Contractor shall submit certified documentation that they have been an authorized distributor and service organization for the OEM for a minimum of three (3) years. The Contractor shall be authorized by the OEM to pass thru the OEM's warranty of the installed equipment to VAMC. In addition, the OEM and Contractor shall accept complete responsibility for the design, installation, certification, operation, and physical support for the System. This documentation, along with the System Contractor and OEM certifications must be provided in writing as part of the Contractor's Technical submittal.
- C. The Contractor's Communications Technicians assigned to the System shall be fully trained, qualified, and certified by the OEM on the engineering, installation, operation, and testing of the System. The Contractor shall provide formal written evidence of current OEM certification(s) for the installer(s) as a part of the submittal or to the COR before being allowed to commence work on the System.
- D. The Contractor shall display all applicable national, state and local licenses.

- E. The Contractor shall submit copy (s) of Certificate of successful completion of OEM's installation/training school for installing technicians of the System's Nurse Call and/or Code Blue equipment being proposed.

1.6 CODES AND PERMITS

- A. Provide all necessary permits and schedule all inspections as identified in the contract's milestone chart, so that the system is proof of performance tested, certified and approved by VAMC and ready for operation on a date directed by the Owner.
- B. The contractor is responsible to adhere to all codes described herein and associated contractual, state and local codes.

1.7 PROJECT RECORD DOCUMENTS (AS BUILTS)

- A. Throughout progress of the Work, maintain an accurate record of changes in Contract Documents. Upon completion of Work, transfer recorded changes to a set of Project Record Documents.
- B. The floor plans shall be marked in pen to include the following:
 - 1. Each device specific locations with UL labels affixed.
 - 2. Conduit locations.
 - 3. Each interface and equipment specific location.
 - 4. Head-end equipment and specific location.
 - 5. Wiring diagram.
 - 6. Labeling and administration documentation.
 - 7. Warranty certificate.
 - 8. System test results.

1.8 WARRANTIES

- A. The Contractor shall warrant the installation to be free from defect in material and workmanship for a period of two (2) years from the date of acceptance of the project by the owner. The Contractor shall agree to remedy covered defects within four (4) hours of notification of major failures or within twenty-four (24) hours of notification for individual station related problems.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft.
- B. Store products in original containers.
- C. Coordinate with the GC for product storage. There may be little or no storage space available on site. Plan to potentially store materials off site.

- D. Do not install damaged products. Remove damaged products from the site and replaced with new product at no cost to the Owner.

1.10 PROJECT CLOSE-OUT

- A. Prior to final inspection and acceptance of the work, remove all debris, rubbish, waste material, tools, construction equipment, machinery and surplus materials from the project site and thoroughly clean your work area.
- B. Before the project closeout date, the Contractor shall submit:
 - 1. OEM Equipment Warranty Certificates.
 - 2. Evidence of compliance with requirements of governing authorities such as the Low Voltage Certificate of Inspection.
 - 3. Project record documents.
 - 4. Instruction manuals and software that is a part of the system.
 - 5. System Guaranty Certificate.
- C. Contractor shall submit written notice that:
 - 1. Contract Documents have been reviewed.
 - 2. Project has been inspected for compliance with contract.
 - 3. Work has been completed in accordance with the contract.

PART 2 - PRODUCTS / FUNCTIONAL REQUIREMENTS

2.1 SYSTEM DESCRIPTION

- A. Furnish and install an extension of the existing Dukane ProCare 2000 Nurse Call System.
- B. The Contractor shall continually employ interfacing methods that are approved by the OEM and VAMC. At a minimum, an acceptable interfacing method requires not only a physical and mechanical connection, but also a matching of signal, voltage, and processing levels with regard to signal quality and impedance. The interface point must adhere to all standards described herein for the full separation of Critical Care and Life Safety systems.
- C. The system hardware shall consist of nurse call devices for a patient communications network comprised of room and corridor dome lights, pull cord and/or emergency push button stations, wiring. All necessary equipment required to meet the intent of these specifications, whether or not enumerated within these specifications, shall be supplied and installed to provide a complete and operating nurse call patient communications network. *It is not acceptable to utilize the telephone cable system for the control and distribution of nurse call signals and equipment.*

- D. All passive distribution equipment shall meet or exceed -80 dB radiation shielding (aka RFI) shielding specifications and be provided with connectors specified by the OEM.
- E. All equipment face plates utilized in the system shall be stainless steel, anodized aluminum or UL approved Cycolac plastic for the areas where provided.
- F. Contractor is responsible for pricing all accessories and miscellaneous equipment required to form a complete and operating system. Unless otherwise noted in this Part, equipment quantities shall be as indicated on the drawings.
- G. System Performance:
 - 1. At a minimum, each distribution, interconnection, interface, terminating point and TCO shall be capable of supporting the Facility's Nurse Call and/or Code Blue System voice and data service as follows:
 - a. Shall be compliant with and not degrade the operating parameters of the Public Switched Telephone Network (PSTN) and the Federal Telecommunications System (FTS) at each PSTN and FTS interface (if attachment is permitted by TVE 0050P3B), interconnection and TCO terminating locations detailed on the contract drawings.
 - b. The System shall provide the following minimum operational functions:
 - 1) Code Blue calls shall be cancelable at the calling station only. The nurse call master station (s) that a managing Code Blue functions shall not have the ability to cancel Code Blue calls.
 - 2) Each Code Blue system shall be able to receive audio calls from all bedside stations simultaneously.
 - 3) Calls placed from any Code Blue station shall generate Code Blue emergency type audible and visual signals at each associated nurse control and duty station, respective dome lights and all local and remote annunciator panels. Calls placed from a bedside station shall generate emergency type visual signals at the bedside station and associated dome light(s) in addition to the previous stated stations and panels.

- 4) Activating the silencing device at any location, while a Code Blue call or system fault is occurring shall mute the audible signals at the alarm location.
 - a) The audible alarm shall regenerate at the end of the selected time-out period until the call or fault is corrected.
 - b) The visual signals shall continue until the call is canceled and/or a fault is corrected. When the fault is corrected, all signals generated by the fault shall automatically cease, returning the System to a standby status.
2. Each System Nurse Call location shall generate a minimum of distinct calls:
 - a. Routine: single flashing dome lights & master station color and audio tone,
 - b. Staff Assist: rapid flashing dome lights & master station color and audio tone,
 - c. Emergency: Red flashing dome lights & master station color and audio tone,
 - d. Code Blue (if equipped): Blue flashing dome lights and master station color and audio tone,
 - e. Each generated call shall be cancelable at ONLY the originating location,

2.3 MANUFACTURERS

- A. This specification is based on a Dukane ProCare 2000 nurse call system manufactured by Dukane, as distributed locally by Sound Engineering, 734-522-2910. B. The products specified shall be new, FCC and UL Listed, labeled and produced by OEM manufacturer of record. An OEM of record shall be defined as a company whose main occupation is the manufacture for sale of the items of equipment supplied and which:
 1. Maintains a stock of replacement parts for the item submitted,
 2. Maintains engineering drawings, specifications, and operating manuals for the items submitted, and
 3. Has published and distributed descriptive literature and equipment specifications on the items of equipment submitted at least 30 days prior to the Invitation for Bid.

B. Equipment Standards and Testing:

1. The System has been defined herein as connected to systems identified as Critical Service performing various Emergency and Life Support Functions. Therefore, at a minimum, the system shall conform to all aforementioned National and/or Local Life Safety Codes (which ever are the more stringent), NFPA, NEC, this specification, JCAHCO Life Safety Accreditation requirements, and the OEM recommendations, instructions, and guidelines.
2. All supplies and materials shall be listed, labeled or certified by UL or a NRTL where such standards have been established for the supplies, materials or equipment.
3. The provided equipment required by the System design and approved technical submittal must conform with each UL standard in effect for the equipment, as of the date of the technical submittal (or the date when the COR approved system equipment necessary to be replaced) was technically reviewed and approved by VAMC. Where a UL standard is in existence for equipment to be used in completion of this contract, the equipment must bear the approved UL seal.
4. Each item of electronic equipment to be provided under this contract must bear the approved UL seal or the seal of the testing laboratory that warrants the equipment has been tested in accordance with, and conforms to the specified standards. The placement of the UL Seal shall be a permanent part of the electronic equipment that is not capable of being transportable from one equipment item to another.

2.4 PRODUCTS

A. General.

1. Contractor is responsible for pricing all accessories and miscellaneous equipment required to form a complete and operating system. The equipment quantities provided herein shall be as indicated on the drawings with the exception of the indicated spare equipment.

B. TIP Cable Systems:

Connect the system to the TIP system provided as a part of Specification Section 27 15 00. Provide additional TIP equipment, interfaces and connections as required by System design. Provide secured pathway(s) and lockable cabinet/rack(s) as required.

C. System Functional Station:

1. Master Control:

- a. Simple Tone and Light:
 - 1) The visual / aural (tone only) system shall be installed according to the same Procedures, guidelines and standards outlined for a regular Nurse Call System for emergency **NOT CODE BLUE OPERATION**.
 - 2) Provide one (1) spare station for each ten (1) stations installed.
- 2. Annunciation:
 - a. Call annunciation shall be split though two nurse station computer work stations.
- D. Distribution System: Refer to Specification Sections 27 11 00, Structured TIP Communications Cables; 27 11 00, TIP Communications Interface and Equipment Rooms Fittings and 27 15 00, HORIZONTAL and Vertical TIP Communications Cabling for additional specific TIP wire and cable standards and installation requirements used to install the Facility's TIP network.
 - 1. In addition to the TIP provided under the aforementioned Specification Sections, the contractor shall provide the following additional TIP installation and testing requirements, provide the following minimum additional System TIP requirements, cables & interconnections:
 - a. Each wire and cable used in the System shall be specifically OEM certified by tags on each reel and recommended and approved for installation in the Facility.
 - b. Copper Cables: Refer to Specification Section 27 15 00, Horizontal and Vertical TIP Communications Cabling; Paragraph 2.4.C12.c. Copper Cables - for minimum technical standards and requirements for additional System voice and data cables.
 - c. Line Level Audio and Microphone Cable:
 - 1) Line level audio and microphone cable for inside racks and conduit.
 - 2) Shielded, twisted pair Minimum 22AWG, stranded conductors and 24AWG drain wire with overall jacket.
 - d. Speaker Level Audio (70.7 Volt RMS):
 - 1) For use with 70.7V speaker circuits.
 - 2) 18AWG stranded pair, minimum.
 - e. All cabling shall be plenum or riser (UL-1666) rated.

2. Raceways, Back Boxes and conduit:

- a. In addition to the Raceways, Equipment Room Fittings provided under Specification Sections 27 15 00 TIP Communication Room Fittings and 27 15 00 - TIP Communications Horizontal and Vertical Cabling, provide the following additional TIP raceway and fittings:
- b. Each raceway that is open top, shall be: UL certified for telecommunications systems, partitioned with metal partitions in order to comply with NEC Parts 517 & 800 to "mechanically separate telecommunications systems of different service, protect the installed cables from falling out when vertically mounted and allow junction boxes to be attached to the side to interface "drop" type conduit cable feeds.
- c. Intercommunication System cable infrastructure: EMT or in J-hooks above accessible ceilings, 24 inches on center.
- d. Junction boxes shall be not less than 2-1/2 inches deep and 6 inches wide by 6 inches long.
- e. Flexible metal conduit is prohibited unless specifically approved by 0050P3B.
- f. System Conduit:
 - 1) The PA system is NFPA listed as Emergency / Public Safety Communication System which requires the entire system to be installed in a separate conduit system.
 - 2) The use of centralized mechanically partitioned wireways may be used to augment main distribution conduit on a case by case basis when specifically approved by VAMC Headquarters (0050P3B).
- 3) Conduit Sleeves:
 - a) The AE has made a good effort to identify where conduit sleeves through full-height and fire rated walls on the drawings, and has instructed the electrician to provide the sleeves as shown on the drawings.
 - b) While the sleeves shown on the drawings will be provided by others, the contractor is responsible for installing conduit sleeves and fire-proofing where necessary. It is often the case, that due to field conditions, the nurse-

call cable may have to be installed through an alternate route. Any conduit sleeves required due to field conditions or those omitted by the engineer shall be provided by the cabling contractor.

g. Device Back Boxes:

- 1) Furnish to the electrical contractor all back boxes required for the PA system devices.
- 2) The electrical contractor shall install the back boxes as well as the system conduit. Coordinate the delivery of the back boxes with the construction schedule.

3. EMERGENCY STATION:

- a. A push-button emergency station shall be provided in each toilet stall and each shower/bath facility in Psychiatric Units. Shower emergency stations shall be installed inside the shower stall at the shower head end. They shall be installed approximately a minimum of 18 inches from the showerhead itself and at a maximum of 72 inches above the finished floor. Each station inside shower and toilet areas shall be equipped with a rubber gasket between the faceplate and wall or be rated by UL as waterproof. The gasket shall cover and water seal the entire back box opening and not extend beyond the sides of the associated faceplate by 1/4" MAX. If the wall is tile or other uneven type material the gasket and associated faceplate shall be provided to completely seal the opening and uneven material surface.
- b. Fasten each emergency station faceplate to the back-boxes with tamperproof screws.
- c. Pressing the push-button on any emergency station shall generate visual signals in the room & corridor dome light(s) and emergency audible and visual signals at the nurse control station.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Execute work in accordance with National, State and local codes, regulations and ordinances.
2. Install work neatly, plumb and square and in a manner consistent with standard industry practice. Carefully protect work from dust,

- paint and moisture as dictated by site conditions. The Contractor will be fully responsible for protection of his work during the construction phase up until final acceptance by the Owner.
3. Install equipment according to OEM's recommendations. Provide any hardware, adaptors, brackets, rack mount kits or other accessories recommended by OEM for correct assembly and installation.
 4. Secure equipment firmly in place, including receptacles, speakers, equipment racks, system cables, etc.
 - a. All supports, mounts, fasteners, attachments and attachment points shall support their loads with a safety factor of at least 5:1.
 - b. Do not impose the weight of equipment or fixtures on supports provided for other trades or systems.
 - c. Any suspended equipment or associated hardware must be certified by the OEM for overhead suspension.
 - d. The Contractor is responsible for means and methods in the design, fabrication, installation and certification of any supports, mounts, fasteners and attachments.
 5. Finishes for any exposed work such as plates, racks, panels, speakers, etc. shall be approved by the Architect, Owner and TVE 0050P3B.
 6. Coordinate cover plates with field conditions. Size and install cover plates as necessary to hide joints between back boxes and surrounding wall. Where cover plates are not fitted with connectors, provide grommets in size and quantity required. Do not allow cable to leave or enter boxes without cover plates installed.
 7. Active electronic component equipment shall consist of solid state components, be rated for continuous duty service, comply with the requirements of FCC standards for telephone and data equipment, systems, and service.
 8. Color code all distribution wiring to conform to the Nurse Call Industry Standard, EIA/TIA, and this document, whichever is the more stringent. At a minimum, all equipment, cable duct and/or conduit, enclosures, wiring, terminals, and cables shall be clearly and permanently labeled according to and using the provided record drawings, to facilitate installation and maintenance.

9. Product Delivery, Storage and Handling:

- a. Delivery: Deliver materials to the job site in OEM's original unopened containers, clearly labeled with the OEM's name and equipment catalog numbers, model and serial identification numbers. The COR may inventory the cable, patch panels, and related equipment.
- b. Storage and Handling: Store and protect equipment in a manner, which will preclude damage as directed by the RE.

B. Wiring Practice - in addition to the MANDATORY infrastructure requirements outlined in VAMC Construction Specifications 27 10 00 - TIP Structured Communications Cabling, 27 11 00 - TIP Communications Rooms Fittings and 27 15 00 - TIP Horizontal and Vertical Communicators Cabling, the following additional practices shall be adhered too:

- 1. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway and Boxes for Electrical Systems."
- 2. Execute all wiring in strict adherence to the National Electrical Code, applicable local building codes and standard industry practices.
- 3. Wiring shall be classified according to the following low voltage signal types:
 - a. Balanced microphone level audio (below -20dBm) or Balanced line level audio (-20dBm to +30dBm)
 - b. 70V audio speaker level audio.
 - c. Low voltage DC control or power (less than 48VDC)
- 4. Where raceway is to be EMT (conduit), wiring of differing classifications shall be run in separate conduit. Where raceway is to be an enclosure (rack, tray, wire trough, utility box) wiring of differing classifications which share the same enclosure shall be mechanically partitioned and separated by at least four (4) inches. Where Wiring of differing classifications must cross, they shall cross perpendicular to one another.
- 5. Do not splice wiring anywhere along the entire length of the run. Make sure cables are fully insulated and shielded from each other and from the raceway for the entire length of the run.
- 6. Do not pull wire through any enclosure where a change of raceway alignment or direction occurs. Do not bend wires to less than radius recommended by manufacturer.

7. Replace the entire length of the run of any wire or cable that is damaged or abraded during installation. There are no acceptable methods of repairing damaged or abraded wiring.
8. Use wire pulling lubricants and pulling tensions as recommended by the OEM.
9. Use grommets around cut-outs and knock-outs where conduit or chase nipples are not installed.
10. Do not use tape-based or glue-based cable anchors.
11. Ground shields and drain wires to the Facility's signal ground system as indicated by the drawings.
12. Field wiring entering equipment racks shall be terminated as follows:
 - a. Provide OEM directed service loops at harness break-outs and at plates, panels and equipment. Loops should be sufficient to allow plates, panels and equipment to be removed for service and inspection.
 - b. Line level and speaker level wiring may be terminated inside the equipment rack using specified terminal blocks (see "Products.") Provide 15% spare terminals inside each rack. Microphone level wiring may only be terminated at the equipment served.
 - c. Employ permanent strain relief for any cable with an outside diameter of 1" or greater.
13. Use only balanced audio circuits unless noted otherwise directed and indicated on the drawings.
14. Make all connections as follows:
 - a. Make all connections using rosin-core solder or mechanical connectors appropriate to the application.
 - b. For crimp-type connections, use only tools that are specified by the manufacturer for the application.
 - c. Use only insulated spade lugs on screw terminals. Spade lugs shall be sized to fit the wire gauge. Do not exceed two lugs per terminal.
 - d. Wire nuts, electrical tape or "Scotch Lock" connections are not acceptable for any application.
15. Wires or cables **previously approved** to be installed outside of conduit, cable trays, wireways, cable duct, etc:

- a. Only when specifically authorized as described herein, will wires or cables be identified and approved to be installed outside of conduit. The wire or cable runs shall be UL rated plenum and OEM certified for use in air plenums.
 - b. Wires and cables shall be hidden, protected, fastened and tied at 600 mm (24 in.) intervals, maximum, as described herein to building structure.
 - c. Closer wire or cable fastening intervals may be required to prevents sagging, maintain clearance above suspended ceilings, remove unsightly wiring and cabling from view and discourage tampering and vandalism. Wire or cable runs, not provided in conduit, that penetrate outside building walls, supporting walls, and two hour fire barriers shall be sleeved and sealed with an approved fire retardant sealant.
 - d. Wire or cable runs to system components installed in walls (i.e.: volume attenuators, circuit controllers, signal, or data outlets, etc.) may, when specifically authorized by the COR, be fished through hollow spaces in walls and shall be certified for use in air plenum areas.
 - e. Completely test all of the cables after installation and replace any defective cables.
 - f. Wires or cables that are installed outside of buildings shall be in conduit, secured to solid building structures. If specifically approved, on a case by case basis, to be run outside of conduit, the wires or cables shall be installed, as described herein. The bundled wires or cables must: Be tied at not less than 460 mm (18 in.) intervals to a solid building structure; have ultra violet protection and betotally waterproof (including all connections). The laying of wires or cables directly on roof tops, ladders, drooping down walls, walkways, floors, etc. is not allowed and will not be approved.
- C. Cable Installation - Cable Installation - In addition to the **MANDATORY** infrastructure requirements outlined in VAMC Construction Specifications 27 10 00 - Structured TIP Communications Cabling, 27 11 00 - TIP Communications Rooms and Fittings and 27 15 00 - TIP Communications Horizontal and Vertical Cabling and the following additional practices shall be adhered too:

1. Support cable on maximum 2'-0" centers. Acceptable means of cable support are cable tray, j-hooks, and bridal rings. Velcro wrap cable bundles loosely to the means of support with plenum rated Velcro straps. Plastic tie wraps are not acceptable as a means to bundle cables.
2. Run cables parallel to walls.
3. Install maximum of 10 cables in a single row of J-hooks. Provide necessary rows of J-hooks as required by the number of cables.
4. Do not lay cables on top of light fixtures, ceiling tiles, mechanical equipment, or ductwork. Maintain at least 2'-0" clearance from all shielded electrical apparatus.
5. All cables shall be tested after the total installation is fully complete. All test results are to be documented. All cables shall pass acceptable test requirements and levels. Contractor shall remedy any cabling problems or defects in order to pass or comply with testing. This includes the re-pull of new cable as required at no additional cost to the Owner.
6. Ends of cables shall be properly terminated on both ends per industry and OEM's recommendations.
7. Provide proper temporary protection of cable after pulling is complete before final dressing and terminations are complete. Do not leave cable lying on floor. Bundle and tie wrap up off of the floor until you are ready to terminate.
8. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at outlets and terminals.
9. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.
10. Bundle, lace, and train conductors to terminal points without exceeding OEM's limitations on bending radii. Install lacing bars and distribution spools.
11. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used.
12. Cable shall not be run through structural members or be in contact with pipes, ducts, or other potentially damaging items.

13. Separation of Wires: (REFER TO RACEWAY INSTALLATION) Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches apart for speaker microphones and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.
14. Serve all cables as follows:
 - a. Cover the end of the overall jacket with a 1" (minimum) length of transparent heat-shrink tubing. Cut unused insulated conductors 2" (minimum) past the heat-shrink, fold back over jacket and secure with cable-tie. Cut unused shield/drain wires 2" (minimum) past the heat shrink and serve as indicated below.
 - b. Cover shield/drain wires with heat-shrink tubing extending back to the overall jacket. Extend tubing ¼" past the end of unused wires, fold back over jacket and secure with cable tie.
 - c. For each solder-type connection, cover the bare wire and solder connection with heat-shrink tubing.
- D. Labeling: Provide labeling in accordance with ANSI/EIA/TIA-606-A. All lettering for Nurse Call and/or Code Blue circuits shall be stenciled using **laser printers**.
 1. Cable and Wires (Hereinafter referred to as "Cable"): Cables shall be labeled at both ends in accordance with ANSI/EIA/TIA-606-A. Labels shall be permanent in contrasting colors. Cables shall be identified according to the System "Record Wiring Diagrams."
 2. Equipment: System equipment shall be permanently labeled with contrasting plastic laminate or Bakelite material. System equipment shall be labeled on the face of the unit corresponding to its source.
 - a. Clearly, consistently, logically and permanently mark switches, connectors, jacks, relays, receptacles and electronic and other equipment.
 - b. Engrave and paint fill all receptacle panels using 1/8" (minimum) high lettering and contrasting paint.
 - c. For rack-mounted equipment, use engraved Lamacoid labels with white 1/8" (minimum) high lettering on black background. Label the front and back of all rack-mounted equipment.

3. Conduit, Cable Duct, and/or Cable Tray: The Contractor shall label all conduit, duct and tray, including utilized GFE, with permanent marking devices or spray painted stenciling a minimum of 3 meters (10 ft.) identifying it as the System. In addition, each enclosure shall be labeled according to this standard.
 4. Termination Hardware: The Contractor shall label TCOs and patch panel connections using color coded labels with identifiers in accordance with ANSI/EIA/TIA-606-A and the "Record Wiring Diagrams."
 5. Ensure each OEM supplied item of equipment has appropriate UL Labels Marks for the service the equipment is performed permanently attached and marked to a non-removal board in the unit. EQUIPMENT INSTALLED NOT BEARING THESE UL MARKS WILL NOT BE ALLOWED TO BE A PART OF THE SYSTEM. THE CONTRACTOR SHALL BEAR ALL COSTS REQUIRED TO PROVIDE REPLACEMENT EQUIPMENT WITH APPROVED UL MARKS.
- E. Conduit and Signal Ducts: When the Contractor and/or OEM determines additional system conduits and/or signal ducts are required in order to meet the system minimum performance standards outlined herein, the contractor shall provide these items as follows:
1. Conduit:
 - a. The Contractor shall employ the latest installation practices and materials. The Contractor shall provide conduit, junction boxes, connectors, sleeves, weather heads, pitch pockets, and associated sealing materials not specifically identified in this document as GFE. Conduit penetrations of walls, ceilings, floors, interstitial space, fire barriers, etc., shall be sleeved and sealed.
 - b. All cables shall be installed in separate conduit and/or signal ducts (exception from the separate conduit requirement to allow Nurse Call and/or Code Blue cables to be installed in partitioned cable tray with voice cables may be granted in writing by the COR if requested). Conduits shall be provided in accordance with Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS, and NEC Articles 517 for Critical Care and 800 for Communications systems, at a minimum.

- c. When metal, plastic covered, etc., flexible cable protective armor or systems are specifically authorized to be provided for use in the System, their installation guidelines and standards shall be as specified herein, Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS, and the NEC.
 - e. Conduit fill (including GFE approved to be used in the system) shall not exceed 40%. Each conduit end shall be equipped with a protective insulator or sleeve to cover the conduit end, connection nut or clamp, to protect the wire or cable during installation and remaining in the conduit. Electrical power conduit shall be installed in accordance with the NEC. AC power conduit shall be run separate from signal conduit.
 - f. Ensure that Nurse Call and/or Code Blue Systems (as identified by NEC Section 517) are completely separated and protected from all other systems.
2. Signal Duct, Cable Duct, or Cable Tray:
- a. The Contractor shall use GFE signal duct, cable duct, and/or cable tray, when identified and approved by the RE.
 - b. Approved signal and/or cable duct shall be a minimum size of 100 mm x 100 mm (4 in. X 4 in.) inside diameter with removable tops or sides, as appropriate. Protective sleeves, guides or barriers are required on all sharp corners, openings, anchors, bolts or screw ends, junction, interface and connection points.
 - c. Approved cable tray shall be fully covered, mechanically and physically partitioned for multiple electronic circuit use, and be UL certified and labeled for use with telecommunication circuits and/or systems. The COR shall approve width and height dimensions.
 - d. All cable junctions and taps shall be accessible. Provide an 8" X 8" X 4" (minimum) junction box attached to the cable duct or raceway for installation of distribution system passive equipment. Ensure all equipment and tap junctions are accessible

3.2 CUTTING, CLEANING AND PATCHING

- A. It shall be the responsibility of the contractor to keep their work area clear of debris and clean area daily at completion of work.
- B. It shall be the responsibility of the contractor to patch and paint any wall or surface that has been disturbed by the execution of this work.

- C. The Contractor shall be responsible for providing any additional cutting, drilling, fitting or patching required that is not indicated as provided by others to complete the Work or to make its parts fit together properly.
- D. The Contractor shall not damage or endanger a portion of the Work or fully or partially completed construction of the Owner or separate contractors by cutting, patching or otherwise altering such construction, or by excavation. The Contractor shall not cut or otherwise alter such construction by the Owner or a separate contractor except with written consent of the Owner and of such separate contractor; such consent shall not be unreasonably withheld. The Contractor shall not unreasonably withhold from the Owner or a separate Contractor the Contractor's consent to cutting or otherwise altering the Work.
- E. Where coring of existing (previously installed) concrete is specified or required, including coring indicated under unit prices, the location of such coring shall be clearly identified in the field and the location shall be approved by the Project Manager prior to commencement of coring work.

3.3 FIREPROOFING

- A. Where Nurse Call and/or Code Blue wires, cables and conduit penetrate fire-rated walls, floors and ceilings, fireproof the opening.
- B. Provide conduit sleeves (if not already provided by electrical contractor) for cables that penetrate fire rated walls and Telecommunications Rooms floors and ceilings. After the cabling installation is complete, install fire proofing material in and around all conduit sleeves and openings. Install fire proofing material thoroughly and neatly. Seal all floor and ceiling penetrations.
- C. Use only materials and methods that preserve the integrity of the fire stopping system and its rating.
- D. Secure the tape in place by a random wrap of glass cloth tape.

3.4 GROUNDING

- A. Ground Nurse Call and/or Code Blue cable shields and equipment to eliminate shock hazard and to minimize ground loops, common mode returns, noise pickup, cross talk, and other impairments as specified in CFM Division 27, Section 27 05 26 - Grounding and Bonding for Communications Systems.

- B. Facility Signal Ground Terminal: Locate at main room or area signal ground within the room (i.e. head end and telecommunications rooms) or area(s) and indicate each signal ground location on the drawings.
- C. Extend the signal ground to inside each equipment cabinet and/or rack. Ensure each cabinet and/or rack installed item of equipment is connected to the extended signal ground. Isolate the signal ground from power and major equipment grounding systems.
- D. Do not use "3rd or 4th" wire internal electrical system conductors for communications signal ground.
- E. Do not connect the signal ground to the building's external lightning protection system.
- F. Do not "mix grounds" of different systems.
- G. Insure grounds of different systems are installed as to not violate OSHA Safety and NEC installation requirements for protection of personnel.

3.4 PROOF OF PERFORMANCE TESTING

- A. Acceptance Test:
 1. After the Nurse Call System has been pretested and the Contractor has submitted the pretest results and certification to the COR, then the Contractor shall schedule an acceptance test date and give the COR 15 working days written notice prior to the date the acceptance test is expected to begin. The System shall be tested in the presence of a TVE 0050P3B and OEM certified representatives. The System shall be tested utilizing the approved test equipment to certify proof of performance and Life Safety / Critical Service compliance. The tests shall verify that the total System meets all the requirements of this specification. The notification of the acceptance test shall include the expected length (in time) of the test.
 2. The acceptance test shall be performed on a "go-no-go" basis. Only those operator adjustments required to show proof of performance shall be allowed. The test shall demonstrate and verify that the installed System does comply with all requirements of this specification under operating conditions. The System shall be rated as either acceptable or unacceptable at the conclusion of the test. Failure of any part of the System that precludes completion of system testing, and which cannot be repaired in four (4) hours, shall be cause for terminating the acceptance test of the System.

Repeated failures that result in a cumulative time of eight (8) hours to affect repairs shall cause the entire System to be declared unacceptable.

3. Retesting of the entire System shall be rescheduled at the convenience of the Government and costs borne by the Contractor at the direction of the SRE.

B. Acceptance Test Procedure:

1. Physical and Mechanical Inspection:

- a. The TVE 0050P3B Representative will tour all major areas where the Nurse Call and/or Code Blue System and all sub-systems are completely and properly installed to insure they are operationally ready for proof of performance testing. A system inventory including available spare parts will be taken at this time. Each item of installed equipment shall be checked to ensure appropriate UL certification labels are affixed.
- b. The System diagrams, record drawings, equipment manuals, TIP Auto CAD Disks, intermediate, and pretest results shall be formally inventoried and reviewed.
- c. Failure of the System to meet the installation requirements of this specification shall be grounds for terminating all testing.

2. Operational Test:

- a. After the Physical and Mechanical Inspection, the central terminating and nurse call master control equipment shall be checked to verify that it meets all performance requirements outlined herein. A spectrum analyzer and sound level meter may be utilized to accomplish this requirement.
- b. The distribution system shall be checked at each interface, junction, and distribution point, first, middle, and last intersectional, room, and bed dome light in each leg to verify that the nurse call distribution system meets all system performance standards.
- c. Additionally, each installed emergency, patient, staff, duty, panic station, intersectional, room, and bed dome light, power supply, code one, and remote annunciator panels shall be checked insuring they meet the requirements of this specification.
- d. Once these tests have been completed, each installed sub-system function shall be tested as a unified, functioning and fully operating system. The typical functions are: nurse follower,

three levels of emergency signaling (i.e. flashing red emergency, flashing white patient emergency, flashing white or combination lights for staff emergency, separate flashing code blue), minimum of 10 minutes of UPS operation, memory saving, minimum of ten station audio paging, canceling emergency calls at each originating station only, and storage and prioritizing of calls.

- e. Individual Item Test: The TVE 0050P3B Representative will select individual items of equipment for detailed proof of performance testing until 100% of the System has been tested and found to meet the contents of this specification. Each item shall meet or exceed the minimum requirements of this document.

3. Test Conclusion:

- a. At the conclusion of the Acceptance Test, using the generated punch list (or discrepancy list) the VAMC and the Contractor shall jointly agree to the results of the test, and reschedule testing on deficiencies and shortages with the COR. Any retesting to comply with these specifications will be done at the Contractor's expense.
- b. If the System is declared unacceptable without conditions, all rescheduled testing expenses will be borne by the Contractor.

- - - E N D - - -

SECTION 27 53 13
WIRELESS CLOCK SYSTEM

PART 1 - GENERAL

1.1 SYSTEM DESCRIPTION AND GENERAL REQUIREMENTS

- A. Furnish and install equipment, accessories, and materials in accordance with these Specifications and drawings to provide an extension to the existing wireless clock system.

1.2 RELATED WORK

- A. Drawings and general provisions of Contract apply to this section.
- B. Requirements of the Following Apply to This Section:
 - 1. Section 26 05 11 - Requirements for Electrical Installations.
 - 2. Section 26 05 21 - Low-Voltage Electrical Power Conductors and Cable (600 Volts and Below).

1.3 SUMMARY

- A. This section addresses the needs and requirements of the wireless clock system. It includes requirements for the wireless clock system components including, but not limited to, the following:
 - 1. Master Clock with Wireless Transceiver.
 - 2. Wireless repeater.
 - 3. Elapsed Time Clock.
 - 4. Secondary Digital Clock.

1.4 DEFINITIONS

- A. Global Positioning System (GPS): A worldwide system that employs 24 orbiting satellites in an integrated network to determine geographic location anywhere in the world, and which employs and transmits atomic time.
- B. Code Division Multiple Access (CDMA): A time synchronization used in the mobile telephone industry.
- C. Ethernet: Provides timesynchronization via SNTP (Simple Network Time Protocol) or Daytime Protocol from time server.

1.5 SUBMITTALS

- A. Product Data:
 - 1. Submit complete specification sheets and catalog data for each component, describing physical characteristics and method of installation.
 - 2. Submit wiring diagrams, detailing wiring for power, signal, and control. Include typical connections for equipment.
 - 3. Submit brochure showing available colors and finishes of clocks.

- B. Samples: Submit one clock for approval. Approved sample shall be tagged and shall be installed in the work at location directed.
- C. Manufacturer's Instructions: Submit complete installation, set-up and maintenance instructions.
- D. Submit a certificate of completion of installation and service training.

1.6 APPLICABLE PUBLICATIONS

- A. National Fire Protection Agency (NFPA) - 70, National Electric Code 2008.

1.7 REGULATORY REQUIREMENTS

- A. System Controller, Transmitter and receiver shall comply with Part 90 of FCC rules, as follows:
 - 1. This device may not cause harmful interference.
 - 2. Transmitter frequency shall be governed by FCC Part 90.35.
 - 3. Transmitter output power shall be governed by FCC Parts 90 and 74.
- B. System shall be installed in compliance with local and state authorities having jurisdiction.

1.8 QUALITY ASSURANCE

- A. Manufacturer:
 - 1. Company specializing in manufacturing commercial timekeeping systems with a minimum of 5 continuous years of documented experience.
 - 2. All items of equipment shall be designed by the manufacturer to function as a complete system and shall be accompanied by the manufacturer's complete service notes and drawings detailing all interconnections
 - 3. Equipment and components furnished shall be of manufacturer's latest model.
- B. Contractor shall be an established communications and electronics contractor for at least three years. Contractor shall utilize a duly authorized distributor of equipment supplied for this project location with full manufacturer's warranty privileges.
- C. Contractor shall show satisfactory evidence, upon request, that supplier maintains a fully equipped service organization capable of furnishing adequate inspection and service to the system. Supplier shall maintain at his facility, necessary spare parts in proper proportion as recommended by manufacturer to maintain and service equipment being supplied.
- D. Electrical Component Standard: Provide work complying with applicable requirements of NFPA 70 "National Electrical Code" including, but not limited to:
 - 1. Article 250, Grounding.

2. Article 300, Part A, Wiring Method.
 3. Article 310, Conductors for General Wiring.
 4. Article 725, Remote Control, Signaling Circuits.
 5. Article 800, Communication Systems.
- E. Installation and start up of systems shall be under direct supervision of a local agency regularly engaged in installation, repair, and maintenance of such systems. Supplier shall be accredited by proposed equipment manufacturers.
- F. Agency providing equipment shall be responsible for providing specified equipment and mentioned services for equipment as specified herein. Agency must be a local authorized distributor of specified equipment for single source of responsibility and shall provide documents proving such. Agency must provide written proof that agency is adequately staffed with factory-trained technicians for the specified equipment. Agency must have established business for and currently be providing services for equipment.
- G. Contractor shall warranty equipment from an authorized distributor of equipment specified under this section. Maintenance shall be provided at no cost to Government for a period of one year (parts and labor) from date of acceptance unless damage or failure is caused by misuse, abuse, neglect, or accident. Additionally, manufacturer supplied products must be covered by three year (parts only) limited warranty from the date of acceptance. Warranty period shall begin on date of purchase by VAMC.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components to the site in the manufacturer's original packaging. Packaging shall contain manufacturer's name and address, product identification number, and other related information.
- B. Store equipment in a clean, dry space within a finished building. Store in original unopened packaging until ready for installation.
- C. Protect products from fumes, construction traffic, and handle carefully to avoid damage.

1.10 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. The Government's approval shall be obtained for all equipment and material before delivery to the job site. Delivery, storage, or installation of equipment or material which has not had prior approval will not be permitted at the job site.

- C. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings, and other data necessary for the Government to ascertain that the proposed equipment and materials comply with specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify equipment being submitted.
- D. Submittals for individual systems and equipment assemblies which consist of more than one item or component shall be made for the system or assembly as a whole. Partial submittals will not be considered for approval.
1. Mark the submittals, "SUBMITTED UNDER SECTION <<NUMBER>>".
 2. Submittals shall be marked to show specification reference including the section and paragraph numbers.
 3. Submit each section separately.
- E. The submittals shall include the following:
1. Information that confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, pictures, nameplate data and test
 2. Elementary and interconnection wiring diagrams for wireless clock system. All terminal points and wiring shall be identified on wiring diagrams.
 3. Parts list which shall include those replacement parts recommended by the equipment manufacturer, quantity of parts, current price and availability of each part.
- F. Manuals: Submit in accordance with Section 01 00 00, GENERAL REQUIREMENTS.
1. Maintenance and Operation Manuals: Submit as required for systems and equipment specified in the technical sections. Furnish four copies, bound in hardback binders, (manufacturer's standard binders) or an approved equivalent. Furnish one complete manual as specified in the technical section but in no case later than prior to performance of systems or equipment test, and furnish the remaining manuals prior to contract completion.
 2. Inscribe the following identification on the cover: the words "MAINTENANCE AND OPERATION MANUAL," the name and location of the system, equipment, building, name of Contractor, and contract number. Include in the manual the names, addresses, and telephone numbers of each subcontractor installing the system or equipment and the local representatives for the system or equipment.

3. Provide a "Table of Contents" and assemble the manual to conform to the table of contents, with tab sheets placed before instructions covering the subject. The instructions shall be legible and easily read, with large sheets of drawings folded in.
4. The manuals shall include:
 - a. Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of the equipment.
 - b. A control sequence describing start-up, operation, and shutdown.
 - c. Description of the function of each principal item of equipment.
 - d. Installation and maintenance instructions.
 - e. Safety precautions.
 - f. Diagrams and illustrations.
 - g. Testing methods.
 - h. Performance data.
 - i. Pictorial "exploded" parts list with part numbers. Emphasis shall be placed on the use of special tools and instruments. The list shall indicate sources of supply, recommended spare parts, and name of servicing organization.
 - j. Appendix; list qualified permanent servicing organizations for support of the equipment, including addresses and certified qualifications.

G. Approvals will be based on complete submission of manuals together with shop drawings.

H. In addition to the requirement of SUBMITTALS, the VAMC reserves the right to request the manufacturer to arrange for a VAMC representative to see typical active systems in operation, when there has been no prior experience with the manufacturer or the type of equipment being submitted.

1.11 FIELD CONDITIONS

A. Clocks shall not be installed until painting and other finish work in each room is complete.

1.12 IN-SERVICE TRAINING

A. Training shall be provided in accordance with Article, INSTRUCTIONS, of Section 01 00 00, GENERAL REQUIREMENTS.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Wireless timekeeping system and its components shall be manufactured by one of the following acceptable manufacturers:

1. Sapling, Inc. www.sapling-inc.com, as distributed locally by Sound Engineering, 734-522-2910, Mr. Gary Snook.
 2. American Time & Signal Company, www.atsclock.com.
 3. Innovation Wireless, www.innovationwireless.com.
 4. Masterclock, www.masterclock.com.
 5. National Time and Signal, www.natsco.net.
 6. Primex Wireless, Inc., www.primexwireless.com, as distributed locally by I.COMM Corporation, 248-960-3700, Mr. Richard Wakefield.
 7. Substitutions: Or equal with similar and salient characteristics. Submit in format noted in VAAR 811.104-71(b) and provide the required information on "equal" products, and to provide descriptive literature in accordance with FAR 52.14-21.
- B. This specification is based on a wireless clock system by Sapling, Inc.
- C. Intent of this Specification is to establish a standard of quality, function, features, and options. It is the responsibility of bidder to ensure that proposed product meets or exceeds every standard set forth in these Specifications.
- D. Functions and features specified are vital to operation of this facility, therefore, acceptance of alternate manufacturers does not release Contractor from strict compliance with requirements of this Specification.
- E. Contractor for this work shall be held to have read Bidding Requirements, General Requirements, and Contract Proposal Forms; and in execution of this work, he will be bound by conditions and requirements therein.
- F. Contractor shall be responsible for providing a complete functional system, including all necessary components whether included in this Specification or not.
- G. In Preparing Bid, Bidder Should Consider the Following:
1. Any prior approval of an alternate system does not automatically exempt supplier from the intent of these Specifications. Failure to comply with operational and functional intent of these Specifications may result in total removal of alternate system at expense of Contractor.

2.2 SYSTEM REQUIREMENTS

- A. Wireless digital clock system with interface capability to GPS and existing systems.

2.3 SYSTEM

- A. System can work as a stand-alone system or in conjunction with an existing wired system, and system shall have interface capability to GPS, network, Internet and existing systems.
- B. System shall be designed to work in an environment where cabling options are not available. System shall be capable of working in 915 to 928 MHz frequency-hopping technology. System shall be capable of automatic transmission of data along 51 alternating frequencies that allows for an enhanced signal, even if there is interference in one of the frequencies.
- C. Each clock in system shall be capable of receiving and transmitting the wireless signal which allows it to be used as a repeater while boosting data stream and sending along the system. With this dual capability there shall be no limit on the number of clocks that can be used in the installation. Clocks shall be designed to automatically work together without interference with each other. System shall be capable of increasing quality of signal while increasing quantity of clocks.
- D. Digital clocks shall be capable of working in one of the following options:
 - 1. 110 volts AC; clock receives and transmits time every one minute.
 - 2. 24 volts AC/DC; clock receives and transmits time every one minute.
 - 3. Elapsed timer shall be capable of working in conjunction with either four digit or six digit digital clocks and shall have ability to count down or count up.
 - a. Digital clock shall include automatic digital calibration for time base to minimize deviation from each other.
 - b. System shall operate in a license-free frequency range where no license is required.

2.4 FCC APPROVAL

- A. This equipment has been tested and found to comply with limits for a Class B digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in a commercial installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this

equipment does cause harmful interference to radio or television reception, which can be determined by turning equipment off and on, user is encouraged to try to correct interference by one or more of following measures

1. Reorient or relocate receiving antenna.
2. Increase separation between equipment and receiver.
3. Connect equipment to an outlet on a circuit different from that to which receiver is connected.
4. Consult dealer or an experienced radio/TV technician.

2.5 PRODUCT

A. Master Clock/Transceiver/Transmitter.

1. Repeaters.

- a. SMA 1000 Wireless Repeater.
- b. Repeater shall be a Sapling Wireless Repeater. Repeater shall wirelessly transmit and receive data. Repeater shall be capable of transmitting to SAL wireless analog clock and SBL wireless digital clock. Repeater shall work on 915 to 928 MHz frequency-hopping technology. Repeater shall wirelessly transmit and receive data. Repeater is to have a maximum antenna size of 7 inches. Repeater shall have an RF input sensitivity of minus 103 dbm. Repeater is to have a RF power output of 27 dbm. Voltage input for repeater shall be 110 volts/60 hertz or 220 volts/50 hertz. Repeater is pending FCC approval.

2. Digital Clock.

- a. Clock shall be a Sapling SBL 2000 wireless digital clock and shall have either a full 2.5 inch or 4.0 inch high efficiency red or blue LED numeral display. Clock will operate as a wireless digital slave clock. Clock shall receive signals from other clocks in surrounding area or from transceiver. Clock shall receive and transmit with 915 to 928MHz frequency-hopping technology. Clocks will be capable of transmitting and receiving time without interfering with each other. Clock shall have data LEDs on the board to display receiving of data. It shall have a 12 or 24 hour display format. Clock will have two levels of adjustable brightness and will feature immediate correction for time changes. Digital clock shall be capable of being installed either surface or double mount. When input is lost, colon on

display of clock shall flash. Clock shall have an anti-glare red or blue bezel with a smooth surface. No external screws shall be visible on bezel or clock housing. Clock shall be FCC compliant, part 15 Section 15,247.

2.6 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements and other conditions affecting performance of wireless clock system.
- B. Do not proceed until unsatisfactory conditions have been corrected.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General.
 - 1. Install system in accordance with applicable codes.
 - 2. Install in accordance with manufacturer's installation manual furnished with the system, for proper installation of each system component.
- B. Examination.
 - 1. Verify that construction is complete in spaces to receive equipment and that rooms are clean and dry.
 - 2. Verify that 120-volt electrical outlet is located within 6 feet of location of master clock and the outlet is operational and properly grounded.
 - 3. Verify that 120-volt electrical outlet is located within 6 feet of location of power supply and the outlet is operational and properly grounded.
- C. Wiring Methods.
 - 1. Conceal wiring except in unfinished spaces.
 - 2. All new wiring on this project must be properly rated for the application.
 - 3. Cable to new devices at new locations shall be installed in a neat and workmanlike manner, following standard procedures used in electrical contracting trade.
 - 4. Exposed wiring will not be permitted under any circumstances on this project.
 - 5. Any wiring, which is considered sloppy by the Architect-Engineer, shall be strictly unacceptable.

6. Upon installation completion, a room-by-room test shall be conducted for every device in the system. A technician shall perform the test and repairs shall be performed as needed at no cost to the Government for any devices, which do not function correctly, including cable. A written room-by-room report following testing and repairs shall be prepared and submitted to the Architect-Engineer.

3.2 FIELD QUALITY CONTROL

- A. Contractor Field Service.
 1. Provide services of a service representative for this project location to supervise field assembly and connection of components and pretesting, testing, and adjustment of system.
- B. Inspection.
 1. Make observations to verify that units and controls are properly labeled.
- C. Testing.
 1. Rectify deficiencies indicated by tests and completely retest work affected by such deficiencies at Contractor's expense. Verify by system test that total system meets Specifications and complies with applicable standards.

3.3 COMMISSIONING

- A. Train VAMC's maintenance personnel in procedures and schedules involved in start-up, set-up, operating, troubleshooting, servicing, and preventative maintenance of system. Operators Manuals and Users Guides shall be provided at time of this training.
- B. Schedule training with COR, with at least seven days advance notice.

3.4 CLEANING AND PROTECTION

- A. Prior to final acceptance, clean exposed surfaces of all system components using cleaning methods recommended by the manufacturer
- B. Protect system components from damage and deterioration.

- - - E N D - - -

SECTION 28 05 11
REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY INSTALLATIONS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section, Requirements for Electronic Safety and Security Installations, applies to all sections of Division 28.
- B. Furnish and install electronic safety and security cabling, systems, equipment and accessories in accordance with the specifications and drawings. Capacities and ratings of, cable and other items and arrangements for the specified items are shown on drawings.

1.2 MINIMUM REQUIREMENTS

- A. References to industry and trade association standards and codes are minimum installation requirement standards.
- B. Drawings and other specification sections shall govern in those instances where requirements are greater than those specified in the above standards.

1.3 QUALIFICATIONS (PRODUCTS AND SERVICES)

- A. Manufacturers Qualifications: The manufacturer shall regularly and presently produce, as one of the manufacturer's principal products, the equipment and material specified for this project, and shall have manufactured the item for at least three years.
- B. Product Qualification:
 - 1. Manufacturer's product shall have been in satisfactory operation, on three installations of similar size and type as this project, for approximately three years.
 - 2. The Government reserves the right to require the Contractor to submit a list of installations where the products have been in operation before approval.
- C. Service Qualifications: There shall be a permanent service organization maintained or trained by the manufacturer which will render satisfactory service to this installation within 24 hours of receipt of notification that service is needed. Submit name and address of service organizations.

1.4 MANUFACTURED PRODUCTS

- A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts shall be available.

- B. When more than one unit of the same class of equipment is required, such units shall be the product of a single manufacturer.
- C. Equipment Assemblies and Components:
 - 1. Components of an assembled unit need not be products of the same manufacturer.
 - 2. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.
 - 3. Components shall be compatible with each other and with the total assembly for the intended service.
 - 4. Constituent parts which are similar shall be the product of a single manufacturer.
- D. Factory wiring shall be identified on the equipment being furnished and on all wiring diagrams.
- E. When Factory Testing Is Specified:
 - 1. The Government shall have the option of witnessing factory tests. The contractor shall notify the VA through the Contracting Officer's Technical Representative (COR) a minimum of 15 working days prior to the manufacturers making the factory tests.
 - 2. Four copies of certified test reports containing all test data shall be furnished to the Contracting Officer's Technical Representative (COR) prior to final inspection and not more than 90 days after completion of the tests.
 - 3. When equipment fails to meet factory test and re-inspection is required, the contractor shall be liable for all additional expenses, including expenses of the Government.

1.5 EQUIPMENT REQUIREMENTS

Where variations from the contract requirements are requested in accordance with the GENERAL CONDITIONS and Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, the connecting work and related components shall include branch circuits, circuit protective devices, conduits, wire, feeders, controls, panels and installation methods.

1.6 EQUIPMENT PROTECTION

- A. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, moisture, cold and rain:

1. During installation, enclosures, equipment, controls, controllers, circuit protective devices, and other like items, shall be protected against entry of foreign matter; and be vacuum cleaned both inside and outside before testing and operating and repainting if required.
2. Damaged equipment shall be, as determined by the Contracting Officer's Technical Representative (COR), placed in first class operating condition or be returned to the source of supply for repair or replacement.
3. Painted surfaces shall be protected with factory installed removable heavy kraft paper, sheet vinyl or equal.
4. Damaged paint on equipment and materials shall be refinished with the same quality of paint and workmanship as used by the manufacturer so repaired areas are not obvious.

1.7 WORK PERFORMANCE

- A. Jobsite safety and worker safety is the responsibility of the contractor.
- B. For work on existing stations, arrange, phase and perform work to assure electronic safety and security service for other buildings at all times. Refer to Article OPERATIONS AND STORAGE AREAS under Section 01 00 00, GENERAL REQUIREMENTS.
- C. New work shall be installed and connected to existing work neatly and carefully. Disturbed or damaged work shall be replaced or repaired to its prior conditions, as required by Section 01 00 00, GENERAL REQUIREMENTS.
- D. Coordinate location of equipment and conduit with other trades to minimize interferences.

1.8 EQUIPMENT INSTALLATION AND REQUIREMENTS

- A. Equipment location shall be as close as practical to locations shown on the drawings.
- B. Inaccessible Equipment:
 1. Where the Government determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, the equipment shall be removed and reinstalled as directed at no additional cost to the Government.
 2. "Conveniently accessible" is defined as being capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as, but not limited to, motors, pumps, belt guards, transformers, piping, ductwork, conduit and raceways.

1.9 EQUIPMENT IDENTIFICATION

- A. Install an identification sign which clearly indicates information required for use and maintenance of equipment.
- B. Nameplates shall be laminated black phenolic resin with a white core with engraved lettering, a minimum of 6 mm (1/4 inch) high. Secure nameplates with screws. Nameplates that are furnished by manufacturer as a standard catalog item, or where other method of identification is herein specified, are exceptions.

1.10 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. The Government's approval shall be obtained for all equipment and material before delivery to the job site. Delivery, storage or installation of equipment or material which has not had prior approval will not be permitted at the job site.
- C. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings and other data necessary for the Government to ascertain that the proposed equipment and materials comply with specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify equipment being submitted.
- D. Submittals for individual systems and equipment assemblies which consist of more than one item or component shall be made for the system or assembly as a whole. Partial submittals will not be considered for approval.
 - 1. Mark the submittals, "SUBMITTED UNDER SECTION_____".
 - 2. Submittals shall be marked to show specification reference including the section and paragraph numbers.
 - 3. Submit each section separately.
- E. The submittals shall include the following:
 - 1. Information that confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, pictures, nameplate data and test reports as required.
 - 2. Elementary and interconnection wiring diagrams for communication and signal systems, control system and equipment assemblies. All terminal points and wiring shall be identified on wiring diagrams.
 - 3. Parts list which shall include those replacement parts recommended by the equipment manufacturer, quantity of parts, current price and availability of each part.

F. Manuals: Submit in accordance with Section 01 00 00, GENERAL REQUIREMENTS.

1. Maintenance and Operation Manuals: Submit as required for systems and equipment specified in the technical sections. Furnish four copies, bound in hardback binders, (manufacturer's standard binders) or an approved equivalent. Furnish one complete manual as specified in the technical section but in no case later than prior to performance of systems or equipment test, and furnish the remaining manuals prior to contract completion.
2. Inscribe the following identification on the cover: the words "MAINTENANCE AND OPERATION MANUAL," the name and location of the system, equipment, building, name of Contractor, and contract number. Include in the manual the names, addresses, and telephone numbers of each subcontractor installing the system or equipment and the local representatives for the system or equipment.
3. Provide a "Table of Contents" and assemble the manual to conform to the table of contents, with tab sheets placed before instructions covering the subject. The instructions shall be legible and easily read, with large sheets of drawings folded in.
4. The manuals shall include:
 - a. Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of the equipment.
 - b. A control sequence describing start-up, operation, and shutdown.
 - c. Description of the function of each principal item of equipment.
 - d. Installation and maintenance instructions.
 - e. Safety precautions.
 - f. Diagrams and illustrations.
 - g. Testing methods.
 - h. Performance data.
 - i. Pictorial "exploded" parts list with part numbers. Emphasis shall be placed on the use of special tools and instruments. The list shall indicate sources of supply, recommended spare parts, and name of servicing organization.
 - j. Appendix; list qualified permanent servicing organizations for support of the equipment, including addresses and certified qualifications.

G. Approvals will be based on complete submission of manuals together with shop drawings.

- H. After approval and prior to installation, furnish the Contracting Officer's Technical Representative (COR) with one sample of each of the following:
1. A 300 mm (12 inch) length of each type and size of wire and cable along with the tag from the coils of reels from which the samples were taken.
 2. Each type of conduit and pathway coupling, bushing and termination fitting.
 3. Conduit hangers, clamps and supports.
 4. Duct sealing compound.
- I. In addition to the requirement of SUBMITTALS, the VAMC reserves the right to request the manufacturer to arrange for a VAMC representative to see typical active systems in operation, when there has been no prior experience with the manufacturer or the type of equipment being submitted.

1.11 SINGULAR NUMBER

Where any device or part of equipment is referred to in these specifications in the singular number (e.g., "the switch"), this reference shall be deemed to apply to as many such devices as are required to complete the installation as shown on the drawings.

1.12 TRAINING

- A. Training shall be provided in accordance with Article, INSTRUCTIONS, of Section 01 00 00, GENERAL REQUIREMENTS.
- B. Training shall be provided for the particular equipment or system as required in each associated specification.
- C. A training schedule shall be developed and submitted by the contractor and approved by the Contracting Officer's Technical Representative (COR) at least 30 days prior to the planned training.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION (NOT USED)

- - - E N D - - -

SECTION 28 05 13
CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing, installation, and connection of the conductors and cables for electronic safety and security.

1.2 RELATED WORK

- A. Sealing around penetrations to maintain the integrity of time rated construction: Section 07 84 00, FIRESTOPPING.
- B. General electrical requirements that are common to more than one section in Division 28: Section 28 05 11, REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY INSTALLATIONS.
- C. Conduits for cables and wiring: Section 28 05 33, RACEWAYS AND BOXES FOR ELECTRONIC SAFETY AND SECURITY.
- D. Requirements for personnel safety and to provide a low impedance path for possible ground fault currents: Section 28 05 26, GROUNDING AND BONDING FOR ELECTRONIC SAFETY AND SECURITY.

1.3 SUBMITTALS

- A. In accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, furnish the following:
 - 1. Manufacturer's Literature and Data: Showing each cable type and rating.
 - 2. Certificates: Two weeks prior to final inspection, deliver to the Contracting Officer's Technical Representative (COR) four copies of the certification that the material is in accordance with the drawings and specifications and has been properly installed.

1.4 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are reference in the text by the basic designation only.
- B. American Society of Testing Material (ASTM):
 - D2301-04.....Standard Specification for Vinyl Chloride
Plastic Pressure Sensitive Electrical Insulating
Tape
- C. Federal Specifications (Fed. Spec.):
 - A-A-59544-00.....Cable and Wire, Electrical (Power, Fixed
Installation)

D. National Fire Protection Association (NFPA):

70-2011.....National Electrical Code (NEC)

E. Underwriters Laboratories, Inc. (UL):

44-02.....Thermoset-Insulated Wires and Cables

83-03.....Thermoplastic-Insulated Wires and Cables

467-01.....Electrical Grounding and Bonding Equipment

486A-01.....Wire Connectors and Soldering Lugs for Use with
Copper Conductors

486C-02.....Splicing Wire Connectors

486D-02.....Insulated Wire Connector Systems for Underground
Use or in Damp or Wet Locations486E-00.....Equipment Wiring Terminals for Use with Aluminum
and/or Copper Conductors493-01.....Thermoplastic-Insulated Underground Feeder and
Branch Circuit Cable

514B-02.....Fittings for Cable and Conduit

1479-03.....Fire Tests of Through-Penetration Fire Stops

PART 2 - PRODUCTS**2.1 CONTROL WIRING**

- A. Unless otherwise specified in other sections of these specifications, control wiring shall be as specified for power and lighting wiring, except the minimum size shall be not less than No. 14 AWG.
- B. Control wiring shall be large enough so that the voltage drop under inrush conditions does not adversely affect operation of the controls.

2.2 COMMUNICATION AND SIGNAL WIRING

- A. Shall conform to the recommendations of the manufacturers of the communication and signal systems; however, not less than what is shown.
- B. Wiring shown is for typical systems. Provide wiring as required for the systems being furnished.
- C. Multi-conductor cables shall have the conductors color coded.

2.3 WIRE LUBRICATING COMPOUND

- A. Suitable for the wire insulation and conduit it is used with, and shall not harden or become adhesive.
- B. Shall not be used on wire for isolated type electrical power systems.

PART 3 - EXECUTION**3.1 INSTALLATION, GENERAL**

- A. Splice cables and wires only in outlet boxes, junction boxes, or pull boxes.

- B. Seal cable and wire entering a building from underground, between the wire and conduit where the cable exits the conduit, with a non-hardening approved compound.
- C. Wire Pulling:
 - 1. Provide installation equipment that will prevent the cutting or abrasion of insulation during pulling of cables.
 - 2. Use ropes made of nonmetallic material for pulling feeders.
 - 3. Attach pulling lines for feeders by means of either woven basket grips or pulling eyes attached directly to the conductors, as approved by the COR.
 - 4. Pull in multiple cables together in a single conduit.

3.2 INSTALLATION IN MANHOLES

- A. Install and support cables in manholes on the steel racks with porcelain or equal insulators. Train the cables around the manhole walls, but do not bend to a radius less than six times the overall cable diameter.

3.3 SPLICE INSTALLATION

- A. Splices and terminations shall be mechanically and electrically secure.
- B. Where the Government determines that unsatisfactory splices or terminations have been installed, remove the devices and install approved devices at no additional cost to the Government.

3.4 CONTROL, COMMUNICATION AND SIGNAL WIRING INSTALLATION

- A. Unless otherwise specified in other sections, install wiring and connect to equipment/devices to perform the required functions as shown and specified.
- B. Except where otherwise required, install a separate power supply circuit for each system so that malfunctions in any system will not affect other systems.
- C. Where separate power supply circuits are not shown, connect the systems to the nearest panelboards of suitable voltages, which are intended to supply such systems and have suitable spare circuit breakers or space for installation.
- D. Install a red warning indicator on the handle of the branch circuit breaker for the power supply circuit for each system to prevent accidental de-energizing of the systems.
- E. System voltages shall be 120 volts or lower where shown on the drawings or as required by the NEC.

3.5 CONTROL, COMMUNICATION AND SIGNAL SYSTEM IDENTIFICATION

- A. Install a permanent wire marker on each wire at each termination.

- B. Identifying numbers and letters on the wire markers shall correspond to those on the wiring diagrams used for installing the systems.
- C. Wire markers shall retain their markings after cleaning.
- D. In each manhole and handhole, install embossed brass tags to identify the system served and function.

3.6 EXISTING WIRING

Unless specifically indicated on the plans, existing wiring shall not be reused for the new installation. Only wiring that conforms to the specifications and applicable codes may be reused. If existing wiring does not meet these requirements, existing wiring may not be reused and new wires shall be installed. All existing wiring disconnected and not reused shall be removed and disposed off from its present location.

- - - E N D - - -

SECTION 28 05 26
GROUNDING AND BONDING FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies general grounding and bonding requirements of electronic safety and security installations for equipment operations.
- B. "Grounding electrode system" refers to all electrodes required by NEC, as well as including made, supplementary, grounding electrodes.
- C. The terms "connect" and "bond" are used interchangeably in this specification and have the same meaning.

1.2 RELATED WORK

- A. Section 28 05 11, REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 28.
- B. Section 28 05 13, CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY: Low Voltage power and lighting wiring.

1.3 SUBMITTALS

- A. Submit in accordance with Section 28 05 11, REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY INSTALLATIONS.
- B. Shop Drawings:
 - 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
 - 2. Include the location of system grounding electrode connections and the routing of aboveground and underground grounding electrode conductors.
- C. Test Reports: Provide certified test reports of ground resistance.
- D. Certifications: Two weeks prior to final inspection, submit four copies of the following to the COR:
 - 1. Certification that the materials and installation is in accordance with the drawings and specifications.
 - 2. Certification, by the Contractor, that the complete installation has been properly installed and tested.

1.4 APPLICABLE PUBLICATIONS

Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.

- A. American Society for Testing and Materials (ASTM):
 - B1-2001.....Standard Specification for Hard-Drawn Copper Wire
 - B8-2004.....Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
- B. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - 81-1983.....IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
- C. National Fire Protection Association (NFPA):
 - 70-2011.....National Electrical Code (NEC)
- D. Underwriters Laboratories, Inc. (UL):
 - 44-2005Thermoset-Insulated Wires and Cables
 - 83-2003Thermoplastic-Insulated Wires and Cables
 - 467-2004Grounding and Bonding Equipment
 - 486A-486B-2003Wire Connectors

PART 2 - PRODUCTS

2.1 GROUNDING AND BONDING CONDUCTORS

- A. Equipment grounding conductors shall be UL 83 insulated stranded copper, except that sizes 6 mm² (10 AWG) and smaller shall be solid copper. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes 25 mm² (4 AWG) and larger shall be permitted to be identified per NEC.
- B. Bonding conductors shall be ASTM B8 bare stranded copper, except that sizes 6 mm² (10 AWG) and smaller shall be ASTM B1 solid bare copper wire.

2.2 SPLICES AND TERMINATION COMPONENTS

Components shall meet or exceed UL 467 and be clearly marked with the manufacturer, catalog number, and permitted conductor size(s).

2.3 GROUND CONNECTIONS

- A. Above Grade:
 - 1. Bonding Jumpers: compression type connectors, using zinc-plated fasteners and external tooth lockwashers.
 - 2. Ground Busbars: Two-hole compression type lugs using tin-plated copper or copper alloy bolts and nuts.
 - 3. Rack and Cabinet Ground Bars: one-hole compression-type lugs using zinc-plated or copper alloy fasteners.

2.4 EQUIPMENT RACK AND CABINET GROUND BARS

Provide solid copper ground bars designed for mounting on the framework of open or cabinet-enclosed equipment racks with minimum dimensions of 4 mm thick by 19 mm wide (3/8 inch x ¾ inch).

2.5 GROUND TERMINAL BLOCKS

At any equipment mounting location (e.g. backboards and hinged cover enclosures) where rack-type ground bars cannot be mounted, provide screw lug-type terminal blocks.

2.6 SPLICE CASE GROUND ACCESSORIES

Splice case grounding and bonding accessories shall be supplied by the splice case manufacturer when available. Otherwise, use 16 mm² (6 AWG) insulated ground wire with shield bonding connectors.

PART 3 - EXECUTION

3.1 GENERAL

- A. Ground in accordance with the NEC, as shown on drawings, and as hereinafter specified.
- B. System Grounding:
 - 1. Secondary service neutrals: Ground at the supply side of the secondary disconnecting means and at the related transformers.
 - 2. Separately derived systems (transformers downstream from the service entrance): Ground the secondary neutral.
 - 3. Isolation transformers and isolated power systems shall not be system grounded.
- C. Equipment Grounding: Metallic structures (including ductwork and building steel), enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits shall be bonded and grounded.

3.2 CORROSION INHIBITORS

When making ground and ground bonding connections, apply a corrosion inhibitor to all contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between the metals used.

3.3 CONDUCTIVE PIPING

- A. Bond all conductive piping systems, interior and exterior, to the building to the grounding electrode system. Bonding connections shall be made as close as practical to the equipment ground bus.

- B. In operating rooms and at intensive care and coronary care type beds, bond the gases and suction piping, at the outlets, directly to the room or patient ground bus.

3.4 WIREWAY GROUNDING

- A. Ground and Bond Metallic Wireway Systems as follows:
 - 1. Bond the metallic structures of wireway to provide 100 percent electrical continuity throughout the wireway system by connecting a 16 mm² (6 AWG) bonding jumper at all intermediate metallic enclosures and across all section junctions.
 - 2. Install insulated 16 mm² (6 AWG) bonding jumpers between the wireway system bonded as required in paragraph 1 above, and the closest building ground at each end and approximately every 16 meters (50 feet).
 - 3. Use insulated 16 mm² (6 AWG) bonding jumpers to ground or bond metallic wireway at each end at all intermediate metallic enclosures and cross all section junctions.
 - 4. Use insulated 16 mm² (6 AWG) bonding jumpers to ground cable tray to column-mounted building ground plates (pads) at each end and approximately every 15 meters.

3.5 GROUND RESISTANCE

- A. Grounding system resistance to ground shall not exceed 5 ohms. Make necessary modifications or additions to the grounding electrode system for compliance without additional cost to the Government. Final tests shall assure that this requirement is met.
- B. Resistance of the grounding electrode system shall be measured using a four-terminal fall-of-potential method as defined in IEEE 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.
- C. Services at power company interface points shall comply with the power company ground resistance requirements.

- D. Below-grade connections shall be visually inspected by the COR prior to backfilling. The Contractor shall notify the COR 24 hours before the connections are ready for inspection.

3.6 GROUNDING FOR RF/EMI CONTROL

- A. Install bonding jumpers to bond all conduit, cable trays, sleeves and equipment for low voltage signaling and data communications circuits. Bonding jumpers shall consist of 100 mm (4 inches) wide copper strip or two 6 mm² (10 AWG) copper conductors spaced minimum 100 mm (4 inches) apart. Use 16 mm² (6 AWG) copper where exposed and subject to damage.
- B. Comply with the following when shielded cable is used for data circuits.
1. Shields shall be continuous throughout each circuit.
 2. Connect shield drain wires together at each circuit connection point and insulate from ground. Do not ground the shield.
 3. Do not connect shields from different circuits together.
 4. Shield shall be connected at one end only. Connect shield to signal reference at the origin of the circuit. Consult with equipment manufacturer to determine signal reference.

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SECTION 28 05 33
RACEWAYS AND BOXES FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing, installation, and connection of conduit, fittings, and boxes to form complete, coordinated, raceway systems. Raceways are required for all electronic safety and security cabling unless shown or specified otherwise.
- B. Definitions: The term conduit, as used in this specification, shall mean any or all of the raceway types specified.

1.2 RELATED WORK

- A. Sealing around penetrations to maintain the integrity of fire rated construction: Section 07 84 00, FIRESTOPPING.
- B. Identification and painting of conduit and other devices: Section 09 91 00, PAINTING.
- C. General electrical requirements and items that is common to more than one section of Division 28: Section 28 05 11, REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY INSTALLATIONS.
- D. Requirements for personnel safety and to provide a low impedance path for possible ground fault currents: Section 28 05 26, GROUNDING AND BONDING FOR ELECTRONIC SAFETY AND SECURITY.

1.3 SUBMITTALS

In accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, furnish the following:

- A. Shop Drawings:
 - 1. Size and location of main feeders;
 - 2. Size and location of panels and pull boxes
 - 3. Layout of required conduit penetrations through structural elements.
 - 4. The specific item proposed and its area of application shall be identified on the catalog cuts.
- B. Certification: Prior to final inspection, deliver to the Contracting Officer's Technical Representative (COR) four copies of the certification that the material is in accordance with the drawings and specifications and has been properly installed.

1.4 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.

- B. National Fire Protection Association (NFPA):
 - 70-2011.....National Electrical Code (NEC)
- C. Underwriters Laboratories, Inc. (UL):
 - 5-01.....Surface Metal Raceway and Fittings
 - 6-03.....Rigid Metal Conduit
 - 50-03.....Enclosures for Electrical Equipment
 - 360-03.....Liquid-Tight Flexible Steel Conduit
 - 467-01.....Grounding and Bonding Equipment
 - 514A-01.....Metallic Outlet Boxes
 - 514B-02.....Fittings for Cable and Conduit
 - 514C-05.....Nonmetallic Outlet Boxes, Flush-Device Boxes and
Covers
 - 797-03.....Electrical Metallic Tubing
 - 1242-00.....Intermediate Metal Conduit
- D. National Electrical Manufacturers Association (NEMA):
 - FB1-03.....Fittings, Cast Metal Boxes and Conduit Bodies
for Conduit, Electrical Metallic Tubing and
Cable

PART 2 - PRODUCTS

2.1 MATERIAL

- A. Conduit Size: In accordance with the NEC, but not less than 13 mm (3/4 inch) unless otherwise shown. Where permitted by the NEC, 13 mm (3/4 inch) flexible conduit may be used for tap connections to recessed lighting fixtures.
- B. Conduit:
 - 1. Rigid galvanized steel: Shall Conform to UL 6, ANSI C80.1.
 - 2. Rigid intermediate steel conduit (IMC): Shall Conform to UL 1242, ANSI C80.6.
 - 3. Electrical metallic tubing (EMT): Shall Conform to UL 797, ANSI C80.3. Maximum size not to exceed 105 mm (4 inch) and shall be permitted only with cable rated 600 volts or less.
 - 4. Liquid-tight flexible metal conduit: Shall Conform to UL 360.
 - 5. Surface metal raceway: Shall Conform to UL 5.
- C. Conduit Fittings:
 - 1. Rigid steel and IMC conduit fittings:
 - a. Fittings shall meet the requirements of UL 514B and ANSI/NEMA FB1.
 - a. Standard threaded couplings, locknuts, bushings, and elbows: Only steel or malleable iron materials are acceptable. Integral retractable type IMC couplings are also acceptable.

- b. Locknuts: Bonding type with sharp edges for digging into the metal wall of an enclosure.
 - c. Bushings: Metallic insulating type, consisting of an insulating insert molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted.
 - d. Erickson (union-type) and set screw type couplings: Approved for use in concrete are permitted for use to complete a conduit run where conduit is installed in concrete. Use set screws of case hardened steel with hex head and cup point to firmly seat in conduit wall for positive ground. Tightening of set screws with pliers is prohibited.
 - e. Sealing fittings: Threaded cast iron type. Use continuous drain type sealing fittings to prevent passage of water vapor. In concealed work, install fittings in flush steel boxes with blank cover plates having the same finishes as that of other electrical plates in the room.
2. Electrical metallic tubing fittings:
- a. Fittings shall meet the requirements of UL 514B and ANSI/NEMA FB1.
 - b. Only steel or malleable iron materials are acceptable.
 - c. Couplings and connectors: Concrete tight and rain tight, with connectors having insulated throats. Use gland and ring compression type couplings and connectors for conduit sizes 50 mm (2 inches) and smaller. Use set screw type couplings with four set screws each for conduit sizes over 50 mm (2 inches). Use set screws of case-hardened steel with hex head and cup point to firmly seat in wall of conduit for positive grounding.
 - d. Indent type connectors or couplings are prohibited.
 - e. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are prohibited.
3. Liquid-tight flexible metal conduit fittings:
- a. Fittings shall meet the requirements of UL 514B and ANSI/NEMA FB1.
 - b. Only steel or malleable iron materials are acceptable.
 - c. Fittings must incorporate a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening. Connectors shall have insulated throats.
4. Surface metal raceway fittings: As recommended by the raceway manufacturer.

5. Expansion and deflection couplings:

- a. Conform to UL 467 and UL 514B.
- b. Accommodate, 19 mm (0.75 inch) deflection, expansion, or contraction in any direction, and allow 30 degree angular deflections.
- c. Include internal flexible metal braid sized to guarantee conduit ground continuity and fault currents in accordance with UL 467, and the NEC code tables for ground conductors.
- d. Jacket: Flexible, corrosion-resistant, watertight, moisture and heat resistant molded rubber material with stainless steel jacket clamps.

D. Conduit Supports:

- 1. Parts and hardware: Zinc-coat or provide equivalent corrosion protection.
- 2. Individual Conduit Hangers: Designed for the purpose, having a pre-assembled closure bolt and nut, and provisions for receiving a hanger rod.
- 3. Multiple conduit (trapeze) hangers: Not less than 38 mm by 38 mm (1-1/2 by 1-1/2 inch), 12 gage steel, cold formed, lipped channels; with not less than 9 mm (3/8 inch) diameter steel hanger rods.
- 4. Solid Masonry and Concrete Anchors: Self-drilling expansion shields, or machine bolt expansion.

E. Outlet, Junction, and Pull Boxes:

- 1. UL-50 and UL-514A.
- 2. Cast metal where required by the NEC or shown, and equipped with rustproof boxes.
- 3. Sheet metal boxes: Galvanized steel, except where otherwise shown.
- 4. Flush mounted wall or ceiling boxes shall be installed with raised covers so that front face of raised cover is flush with the wall. Surface mounted wall or ceiling boxes shall be installed with surface style flat or raised covers.

F. Wireways: Equip with hinged covers, except where removable covers are shown.

PART 3 - EXECUTION

3.1 PENETRATIONS

A. Cutting or Holes:

- 1. Locate holes in advance where they are proposed in the structural sections such as ribs or beams. Obtain the approval of the Contracting Officer's Technical Representative (COR) prior to drilling through structural sections.

2. Cut holes through concrete and masonry in new and existing structures with a diamond core drill or concrete saw. Pneumatic hammer, impact electric, hand or manual hammer type drills are not allowed, except where permitted by the COR as required by limited working space.
- B. Fire Stop: Where conduits, wireways, and other electronic safety and security raceways pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases as specified in Section 07 84 00, FIRESTOPPING, with rock wool fiber or silicone foam sealant only. Completely fill and seal clearances between raceways and openings with the fire stop material.
- C. Waterproofing: At floor, exterior wall, and roof conduit penetrations, completely seal clearances around the conduit and make watertight as specified in Section 07 92 00, JOINT SEALANTS.

3.2 INSTALLATION, GENERAL

- A. Install conduit as follows:
 1. In complete runs before pulling in cables or wires.
 2. Flattened, dented, or deformed conduit is not permitted. Remove and replace the damaged conduits with new undamaged material.
 3. Assure conduit installation does not encroach into the ceiling height head room, walkways, or doorways.
 4. Cut square with a hacksaw, ream, remove burrs, and draw up tight.
 5. Mechanically continuous.
 6. Independently support conduit at 8'0" on center. Do not use other supports i.e., (suspended ceilings, suspended ceiling supporting members, lighting fixtures, conduits, mechanical piping, or mechanical ducts).
 7. Support within 300 mm (1 foot) of changes of direction, and within 300 mm (1 foot) of each enclosure to which connected.
 8. Close ends of empty conduit with plugs or caps at the rough-in stage to prevent entry of debris, until wires are pulled in.
 9. Conduit installations under fume and vent hoods are prohibited.
 10. Secure conduits to cabinets, junction boxes, pull boxes and outlet boxes with bonding type locknuts. For rigid and IMC conduit installations, provide a locknut on the inside of the enclosure, made up wrench tight. Do not make conduit connections to junction box covers.
 11. Flashing of penetrations of the roof membrane is specified in Section 07 60 00, FLASHING AND SHEET METAL.

12. Do not use aluminum conduits in wet locations.

13. Unless otherwise indicated on the drawings or specified herein, all conduits shall be installed concealed within finished walls, floors and ceilings.

B. Conduit Bends:

1. Make bends with standard conduit bending machines.
2. Conduit hickey may be used for slight offsets, and for straightening stubbed out conduits.
3. Bending of conduits with a pipe tee or vise is prohibited.

C. Layout and Homeruns:

1. Install conduit with wiring, including homeruns, as shown.
2. Deviations: Make only where necessary to avoid interferences and only after drawings showing the proposed deviations have been submitted approved by the Contracting Officer's Technical Representative (COR).

D. Fire Alarm:

1. Fire alarm conduit shall be painted red (a red "top-coated" conduit from the conduit manufacturer may be used in lieu of painted conduit) in accordance with the requirements of Section 28 31 00, Fire Detection and Alarm.

3.3 CONCEALED WORK INSTALLATION

A. In Concrete:

1. Conduit: Rigid steel, IMC or EMT. Do not install EMT in concrete slabs that are in contact with soil, gravel or vapor barriers.
2. Align and run conduit in direct lines.
3. Install conduit through concrete beams only when the following occurs:
 - a. Where shown on the structural drawings.
 - b. As approved by the Contracting Officer's Technical Representative (COR) prior to construction, and after submittal of drawing showing location, size, and position of each penetration.
4. Installation of conduit in concrete that is less than 75 mm (3 inches) thick is prohibited.
 - a. Conduit outside diameter larger than 1/3 of the slab thickness is prohibited.
 - b. Space between conduits in slabs: Approximately six conduit diameters apart, except one conduit diameter at conduit crossings.
 - c. Install conduits approximately in the center of the slab so that there will be a minimum of 19 mm (3/4 inch) of concrete around the conduits.

5. Make couplings and connections watertight. Use thread compounds that are UL approved conductive type to insure low resistance ground continuity through the conduits. Tightening set screws with pliers is prohibited.

B. Furred or Suspended Ceilings and in Walls:

1. Conduit for conductors above 600 volts:
 - a. Rigid steel or rigid aluminum.
 - b. Aluminum conduit mixed indiscriminately with other types in the same system is prohibited.
2. Conduit for conductors 600 volts and below:
 - a. Rigid steel, IMC, rigid aluminum, or EMT. Different type conduits mixed indiscriminately in the same system is prohibited.
3. Align and run conduit parallel or perpendicular to the building lines.
4. Connect recessed lighting fixtures to conduit runs with maximum 1800 mm (six feet) of flexible metal conduit extending from a junction box to the fixture.
5. Tightening set screws with pliers is prohibited.

3.4 EXPOSED WORK INSTALLATION

- A. Unless otherwise indicated on the drawings, exposed conduit is only permitted in mechanical and electrical rooms.
- B. Conduit for conductors above 600 volts:
 1. Rigid steel or rigid aluminum.
 2. Aluminum conduit mixed indiscriminately with other types in the same system is prohibited.
- C. Conduit for Conductors 600 volts and below:
 1. Rigid steel, IMC, rigid aluminum, or EMT. Different type of conduits mixed indiscriminately in the system is prohibited.
- D. Align and run conduit parallel or perpendicular to the building lines.
- E. Install horizontal runs close to the ceiling or beams and secure with conduit straps.
- F. Support horizontal or vertical runs at not over 2400 mm (eight foot) intervals.
- G. Surface metal raceways: Use only where shown.
- H. Painting:
 1. Paint exposed conduit as specified in Section 09 91 00, PAINTING.

2. Paint all conduits containing cables rated over 600 volts safety orange. Refer to Section 09 91 00, PAINTING for preparation, paint type, and exact color. In addition, paint legends, using 50 mm (two inch) high black numerals and letters, showing the cable voltage rating. Provide legends where conduits pass through walls and floors and at maximum 6000 mm (20 foot) intervals in between.

3.5 EXPANSION JOINTS

- A. Conduits 75 mm (3 inches) and larger, that are secured to the building structure on opposite sides of a building expansion joint, require expansion and deflection couplings. Install the couplings in accordance with the manufacturer's recommendations.
- B. Provide conduits smaller than 75 mm (3 inches) with junction boxes on both sides of the expansion joint. Connect conduits to junction boxes with sufficient slack of flexible conduit to produce 125 mm (5 inch) vertical drop midway between the ends. Flexible conduit shall have a copper green ground bonding jumper installed. In lieu of this flexible conduit, expansion and deflection couplings as specified above for 375 mm (15 inches) and larger conduits are acceptable.
- C. Install expansion and deflection couplings where shown.

3.6 CONDUIT SUPPORTS, INSTALLATION

- A. Safe working load shall not exceed 1/4 of proof test load of fastening devices.
- B. Use pipe straps or individual conduit hangers for supporting individual conduits. Maximum distance between supports is 2.5 m (8 foot) on center.
- C. Support multiple conduit runs with trapeze hangers. Use trapeze hangers that are designed to support a load equal to or greater than the sum of the weights of the conduits, wires, hanger itself, and 90 kg (200 pounds). Attach each conduit with U-bolts or other approved fasteners.
- D. Support conduit independently of junction boxes, pull boxes, fixtures, suspended ceiling T-bars, angle supports, and similar items.
- E. Fasteners and Supports in Solid Masonry and Concrete:
 1. New Construction: Use steel or malleable iron concrete inserts set in place prior to placing the concrete.
 2. Existing Construction:
 - a. Steel expansion anchors not less than 6 mm (1/4 inch) bolt size and not less than 28 mm (1-1/8 inch) embedment.
 - b. Power set fasteners not less than 6 mm (1/4 inch) diameter with depth of penetration not less than 75 mm (3 inches).
 - c. Use vibration and shock resistant anchors and fasteners for attaching to concrete ceilings.

- F. Hollow Masonry: Toggle bolts are permitted.
- G. Bolts supported only by plaster or gypsum wallboard are not acceptable.
- H. Metal Structures: Use machine screw fasteners or other devices specifically designed and approved for the application.
- I. Attachment by wood plugs, rawl plug, plastic, lead or soft metal anchors, or wood blocking and bolts supported only by plaster is prohibited.
- J. Chain, wire, or perforated strap shall not be used to support or fasten conduit.
- K. Spring steel type supports or fasteners are prohibited for all uses except: Horizontal and vertical supports/fasteners within walls.
- L. Vertical Supports: Vertical conduit runs shall have riser clamps and supports in accordance with the NEC and as shown. Provide supports for cable and wire with fittings that include internal wedges and retaining collars.

3.7 BOX INSTALLATION

- A. Boxes for Concealed Conduits:
 - 1. Flush mounted.
 - 2. Provide raised covers for boxes to suit the wall or ceiling, construction and finish.
- B. In addition to boxes shown, install additional boxes where needed to prevent damage to cables and wires during pulling in operations.
- C. Remove only knockouts as required and plug unused openings. Use threaded plugs for cast metal boxes and snap-in metal covers for sheet metal boxes.
- D. Outlet boxes in the same wall mounted back-to-back are prohibited. A minimum 600 mm (24 inch), center-to-center lateral spacing shall be maintained between boxes.)
- E. Minimum size of outlet boxes for ground fault interrupter (GFI) receptacles is 100 mm (4 inches) square by 55 mm (2-1/8 inches) deep, with device covers for the wall material and thickness involved.
- F. Stencil or install phenolic nameplates on covers of the boxes identified on riser diagrams; for example "SIG-FA JB No. 1".
- G. On all Branch Circuit junction box covers, identify the circuits with black marker.

3.8 ELECTRONIC SAFETY AND SECURITY CONDUIT

- A. Install the electronic safety and security raceway system as shown on drawings.
- B. Minimum conduit size of 19 mm (3/4 inch), but not less than the size shown on the drawings.

- C. All conduit ends shall be equipped with insulated bushings.
- D. All 100 mm (four inch) conduits within buildings shall include pull boxes after every two 90 degree bends. Size boxes per the NEC.
- E. Vertical conduits/sleeves through closets floors shall terminate not less than 75 mm (3 inches) below the floor and not less than 75 mm (3 inches) below the ceiling of the floor below.
- F. Terminate conduit runs to/from a backboard in a closet or interstitial space at the top or bottom of the backboard. Conduits shall enter communication closets next to the wall and be flush with the backboard.
- G. Where drilling is necessary for vertical conduits, locate holes so as not to affect structural sections such as ribs or beams.
- H. All empty conduits located in communications closets or on backboards shall be sealed with a standard non-hardening duct seal compound to prevent the entrance of moisture and gases and to meet fire resistance requirements.
- I. Conduit runs shall contain no more than four quarter turns (90 degree bends) between pull boxes/backboards. Minimum radius of communication conduit bends shall be as follows (special long radius):

Sizes of Conduit Trade Size	Radius of Conduit Bends mm, Inches
$\frac{3}{4}$	150 (6)
1	230 (9)
1-1/4	350 (14)
1-1/2	430 (17)
2	525 (21)
2-1/2	635 (25)
3	775 (31)
3-1/2	900 (36)
4	1125 (45)

- J. Furnish and install 19 mm (3/4 inch) thick fire retardant plywood specified in on the wall of communication closets where shown on drawings . Mount the plywood with the bottom edge 300 mm (one foot) above the finished floor.
- K. Furnish and pull wire in all empty conduits. (Sleeves through floor are exceptions).

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SECTION 28 13 11
PHYSICAL ACCESS CONTROL SYSTEM (PACS)

PART 1 - GENERAL

1.1 DESCRIPTION

Provide and install an extension to the existing Physical Access Control System, hereinafter referred to as the PACS.

1.2 RELATED WORK

- A. For firestopping application and use, Section 07 84 00, FIRESTOPPING.
- B. For labeling and signs, Section 10 14 00, SIGNAGE.
- C. For connection of high voltage, Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- D. For power cables, Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW).
- E. For grounding of equipment, Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.
- F. For infrastructure, Section 26 05 33, RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS.
- G. For alarm systems, Section 28 16 11, INTRUSION DETECTION SYSTEM (IDS).
- H. For security camera systems, Section 28 23 00 VIDEO SURVEILLANCE.
- I. For General Requirements, Section 01 00 00, GENERAL REQUIREMENTS.

1.3 QUALITY ASSURANCE

- A. The Contractor shall be responsible for providing, installing, and the operation of the PACS as shown. The Contractor shall also provide certification as required.
- B. The security system will be installed and tested to ensure all components are fully compatible as a system.
- C. The Contractor or security sub-contractor shall be a licensed security Contractor as required within the state or jurisdiction of where the installation work is being conducted.

1.4 SUBMITTALS

- A. Submit below items in conjunction with Master Specification Sections 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES, and Section 02 41 00, DEMOLITION.
- B. Provide certificates of compliance with Section 1.3, Quality Assurance.

- C. Provide a complete and thorough pre-installation and as-built design package in both electronic format and on paper, minimum size 48 x 48 inches (1220 x 1220 millimeters); drawing submittals shall be per the established project schedule.
- D. Pre-installation design and as-built packages shall include:
 - 1. Index Sheet that shall:
 - a. Define each page of the design package to include facility name, building name, floor, and sheet number.
 - b. Provide a complete list of all security abbreviations and symbols.
 - c. Reference all general notes that are utilized within the design package.
 - d. Specification and scope of work pages for all individual security systems that are applicable to the design package that will:
 - 1) Outline all general and job specific work required within the design package.
 - 2) Provide a detailed device identification table outlining device Identification (ID) and use for all security systems equipment utilized in the design package.
 - 2. Drawing sheets that will be plotted on the individual floor plans or site plans shall:
 - a. Include a title block as defined above.
 - b. Clearly define the drawings scale in both standard and metric measurements.
 - c. Provide device identification and location.
 - d. Address all signal and power conduit runs and sizes that are associated with the design of the electronic security system and other security elements (e.g., barriers, etc.).
 - e. Identify all pull box and conduit locations, sizes, and fill capacities.
 - f. Address all general and drawing specific notes for a particular drawing sheet.
 - 3. A detailed riser drawing for each applicable security subsystem shall:
 - a. Indicate the sequence of operation.

- b. Relationship of integrated components on one diagram.
 - c. Include the number, size, identification, and maximum lengths of interconnecting wires.
 - d. Wire/cable types shall be defined by a wire and cable schedule. The schedule shall utilize a lettering system that will correspond to the wire/cable it represents (example: A = 18 AWG/1 Pair Twisted, Unshielded). This schedule shall also provide the manufacturer's name and part number for the wire/cable being installed.
4. A detailed system drawing for each applicable security system shall:
- a. Clearly identify how all equipment within the system, from main panel to device, shall be laid out and connected.
 - b. Provide full detail of all system components wiring from point-to-point.
 - c. Identify wire types utilized for connection, interconnection with associate security subsystems.
 - d. Show device locations that correspond to the floor plans.
 - e. All general and drawing specific notes shall be included with the system drawings.
5. A detailed schedule for all of the applicable security subsystems shall be included. All schedules shall provide the following information:
- a. Device ID.
 - b. Device Location (e.g. site, building, floor, room number, location, and description).
 - c. Mounting type (e.g. flush, wall, surface, etc.).
 - d. Power supply or circuit breaker and power panel number.
 - e. In addition, for the PACS, provide the door ID, door type (e.g. wood or metal), locking mechanism (e.g. strike or electromagnetic lock) and control device (e.g. card reader or biometrics).
6. Detail and elevation drawings for all devices that define how they were installed and mounted.

- E. Pre-installation design packages shall go through a full review process conducted by the Contractor along with a VAMC representative to ensure all work has been clearly defined and completed. All reviews shall be conducted in accordance with the project schedule. There shall be one (1) stage to the review process:
 - 1. 100 percent
- F. Provide manufacturer security system product cut-sheets. Submit for approval at least 30 days prior to commencement of formal testing, a Security System Operational Test Plan. Include procedures for operational testing of each component and security subsystem, to include performance of an integrated system test.
- G. Submit manufacture's certification of Underwriters Laboratories, Inc. (UL) listing as specified. Provide all maintenance and operating manuals per Section 01 00 00, GENERAL REQUIREMENTS.

1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below (including amendments, addenda, revisions, supplement, and errata) form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American National Standards Institute (ANSI)/ Security Industry Association (SIA):
 - AC-01.....Access Control: Wiegand Card Reader Interface
Standard
 - AC-03.....Access Control: Badging Techniques
- C. American National Standards Institute (ANSI)/ International Code Council (ICC):
 - A117.1.....Standard on Accessible and Usable Buildings and
Facilities
- D. Department of Justice American Disability Act (ADA)
 - 28 CFR Part 36-90.....ADA Standards for Accessible Design
- E. Government Accountability Office (GAO):
 - GAO-03-8-02.....Security Responsibilities for Federally Owned
and Leased Facilities
- F. National Electrical Contractors Association
 - 303-2005.....Installing Closed Circuit Television (CCTV)
Systems

- G. National Electrical Manufacturers Association (NEMA):
 - 250-03.....Enclosures for Electrical Equipment (1000 Volts Maximum)
- H. National Fire Protection Association (NFPA):
 - 70-2011..... Article 780-National Electrical Code
- I. Underwriters Laboratories, Inc. (UL):
 - 294-99.....Standard for Access Control
 - 305-97.....Standard for Panic Hardware
 - 639-97.....Standard for Intrusion-Detection Units
 - 752-05.....Standard for Bullet-Resisting Equipment
 - 827-96.....Central Station Alarm Services
 - 1076-95.....Standards for Proprietary Burglar Alarm Units and Systems
 - 1981-03.....Central Station Automation System
 - 2058-05.....High Security Electronic Locks
- J. Homeland Security Presidential Directive (HSPD):
 - HSPD-12.....Policy for a Common Identification Standard for Federal Employees and Contractors
- K. Federal Information Processing Standards (FIPS):
 - FIPS-201.....Personal Identity Verification (PIV) of Federal Employees and Contractors
- L. National Institute of Standards and Technology (NIST):
 - IR 6887 V2.1.....Government Smart Card Interoperability Specification (GSC-IS)
 - Special Pub 800-96.....PIV Card Reader Interoperability Guidelines
- M. Institute of Electrical and Electronics Engineers (IEEE):
 - C62.41.....IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits
- N. International Organization for Standardization (ISO):
 - 7810.....Physical Characteristics of Credit Card Size Document
 - 7811.....Physical Characteristics for Magnetic Stripe Cards
 - 7816-1.....Physical Characteristics of the Card
 - 7816-2.....Dimensions and Contact Position of the card
 - 7816-3.....Electrical Signals and Transmission Protocols
 - 7816-4.....Inter-Industry Command for Interchange

14443.....RFID cards; Contactless Proximity Cards
 Operating at 13.56 MHz in up to 5 inches
 distance

15693.....RFID cards; Contactless Vicinity Cards
 Operating at 13.56 MHz in up to 50 inches
 distance

O. Uniform Federal Accessibility Standards (UFAS) 1984

P. ADA Standards for Accessible Design 1994

1.6 WARRANTY OF CONSTRUCTION.

Warrant PACS work subject to the Article "Warranty of Construction" of
 FAR clause 52.246-21.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS

- A. All equipment associated within the PACS shall be UL 294 compliant and rated for continuous operation. Environmental conditions (i.e. temperature, humidity, wind, and seismic activity) shall be taken under consideration at each facility and site location prior to installation of the equipment.
- B. All equipment shall operate on a 120 or 240 volts alternating current (VAC); 50 Hz or 60 Hz AC power system unless documented otherwise in subsequent sections listed within this specification. All equipment shall have a back-up source of power that will provide a minimum of 96 hours of run time in the event of a loss of primary power to the facility.
- C. The system shall be designed, installed, and programmed in a manner that will allow for easy of operation, programming, servicing, maintenance, testing, and upgrading of the system.
- D. All equipment and materials for the system will be compatible to ensure correct operation as outlined in FIPS 201, March 2006 and HSPD-12.

2.2 EQUIPMENT ITEMS

- A. The security system characteristics listed in this section will serve as a guide in selection of equipment and materials for the PACS. If updated or more suitable versions are available then the Contracting Officer's Technical Representative (COT) will approve the acceptance of prior to an installation.
- B. PACS equipment shall meet or exceed all requirements listed below.

C. A PACS shall be comprised of the following components:

1. Control/Communications Panels
2. Electronic Security Management System
3. Card Reader
4. Door Status Indicators
5. Entry Control Device
6. Power Supplies
7. Wires and Cables

D. Control/Communication Panels:

1. Shall be a central point provided for monitoring, controlling, and programming the PACS.
2. Shall provide a means of controlling up to 16 doors per panel.
3. Shall be expandable and provide a means of networking to the existing PACS system and provide overall control of all doors on the PACS via a primary panel.
4. Shall be system specific addressable, Internet Protocol (IP) addressable, and programmable via a computer.
5. Shall be able to be interfaced directly from a computer or via the Internet or Intranet. Access to the panels shall be password protected. All individuals with access to the panels shall have a user specific password.
6. Shall be of the same manufacturer and part numbers as existing units to ensure full compatibility within the system.
7. The panel programming shall be written so that all system modules (e.g. access control, alarm monitoring, credential management, intrusion detection, asset management, etc.) are developed and built from a unified 32-bit source code set. There absolutely shall not be separate source code bases for the individual modules of the PACS.
8. Shall allow for the operation and control of up to 16 doors.
9. Shall consist of or have the equivalent of, at a minimum, a General Control Module and an Access Control Module. Both modules shall be programmable via a computer.
10. The General Control Module shall:
 - a. Provide for full distributed processing of access control and alarm monitoring operations.

- b. Store the following information and function using a high speed, local 32-bit microprocessor:
 - 1) access levels
 - 2) hardware configurations
 - 3) programmed alarm outputs assigned at a administration client workstation
- c. Process all access granted/denied decisions to provide fast responses to card reader transactions. A fully configured general control module with 64 card readers shall require less than one-half (0.5) seconds to grant access to an authorized cardholder or deny access to an unauthorized cardholder.
- d. Meet the following minimum requirements:
 - 1) A minimum host communications speed of 115,200 bps.
 - 2) Support direct connect connections.
 - 3) Have remote dial up.
 - 4) Minimum on-board memory of eight (8) MB.
 - 5) Local Area Network (LAN) Support RJ45 (10/100baseT) Ethernet Interface Token Ring four (4) MB connectivity.
 - 6) Minimum memory storage of up to 5,000 cardholders and 100,000 events.
 - 7) Downstream ports for connecting card readers and data gathering panels via RS-485 multi-drop wiring configuration.
 - 8) Support of multiple card technologies.
 - 9) Supervised Communications with PACS system software.
 - 10) Support of up to eight card formats and facility codes.
 - 11) RS-485 Full Duplex, UL 1076 Grade AA communication channel to the system head-end.
 - 12) Integration with all manufacturers' card readers.
 - 13) Biometric Interface Support.
 - 14) 12 VAC or 12 volts direct current (VDC) input power via a UL certified step-down transformer or power supply.
 - 15) Issue Code Support for both Magnetic and Wiegand Card Formats.
 - 16) Individual Shunt Times
 - 17) Up to Nine Digit PIN Codes.
 - 18) Downstream serial RS-232 device support.
 - 19) Status LED's to identify normal component and communication status.

11. The access control module shall:
 - a. Control up to 16 doors utilizing input and output relays that are fully programmable via network software.
 - b. Input relays shall meet the following minimum requirements:
 - 1) Provide up to 16 UL 1076 analog unsupervised alarm input zones to monitor and report alarm conditions, power faults, and tampers.
 - 2) Operate independently and in conjunction with output relays, which will send an output signal to a corresponding output device upon alarm input activation. Once an alarm has been received, the input relay shall activate any or all alarm outputs.
 - 3) Contain the following features:
 - a) UL 294 Certified.
 - b) Alarm contact status scanning at up to 120 times per second for each zone.
 - c) A low power Complementary-symmetry/metal-oxide semiconductor (CMOS) microprocessor.
 - d) Filtered data for noise rejection to prevent false alarms.
 - e) Up to 16 supervised inputs.
 - f) 12 VAC or 12 VDC Input Power.
 - g) Two (2) dedicated inputs for tamper and power status.
12. Output relays shall meet the following minimum requirements:
 - a. Shall be capable of controlling a corresponding output device upon any input activation or on command from the PACS.
 - b. Shall be capable of responding to:
 - 1) Input alarms.
 - 2) Commands from a System Operator.
 - 3) Time zone control commands for automatic operation.
 - c. Shall be capable of:
 - 1) Pulsing for a predetermined duration. Duration shall be programmable for each relay individually.
 - 2) Responding on command from the System Operator to pulse, command on, command off, or reset to normal state.
 - 3) Operating outputs rated at 5 amps (A) @ 30 VDC.

E. Card Readers:

1. Shall be utilized for controlling the locking hardware on a door and allows for reporting back to the main control panel with the time/date the door was accessed, the name of the person accessing the point of entry, and its location.
2. Will be fully programmable and addressable, locally and remotely, and hardwired to the system.
3. Shall be individually home run to the local door control panel.
4. Shall be installed in a manner that they comply with:
 - a. The Uniform Federal Accessibility Standards (UFAS)
 - b. The Americans with Disabilities Act (ADA)
 - c. The ADA Standards for Accessible Design
5. Shall contain read head electronics, and a sender to encode digital door control signals.
6. LED's shall be utilized to indicate card reader status and access status.
7. Shall be able to support a user defined downloadable off-line mode of operation (e.g. locked, unlocked, or facility code), which will go in effect during loss of communication with the main control panel.
8. Shall provide audible feedback to indicate access granted/denied decisions. Upon a card swipe, two audible tones or beeps shall indicate access granted and three tones or beeps shall indicate access denied. All keypad buttons shall provide (tactile?? What does this mean) audible feedback.
9. Shall have a minimum of two programmable inputs and two programmable outputs.
 - a. Shall include a Light Emitting Diode (LED) or other type of visual indicator display and provide visual or visual and audible status indications and user prompts. The display shall indicate power on/off, and whether user passage requests have been accepted or rejected. The design of the keypad display or keypad enclosure shall limit the maximum horizontal and vertical viewing angles of the keypad. The maximum horizontal viewing angle shall

be plus and minus five (5) degrees or less off a vertical plane perpendicular to the plane of the face of the keypad display. The maximum vertical viewing angle shall be plus and minus 15 degrees or less off a horizontal plane perpendicular to the plane of the face of the keypad display.

- b. Shall respond to passage requests by generating a signal to the local processor. The response time shall be 800 milliseconds or less from the time the last alphanumeric symbol is entered until a response signal is generated.
 - c. Shall be powered from the source as designed and shall not dissipate more than 150 Watts.
 - d. Shall be suitable for surface, semi-flush, pedestal, or weatherproof mounting as required.
 - e. Shall provide a means for users to indicate a duress situation by entering a special code.
10. Card readers shall come in the following format:
- a. Proximity (PROX) Card Reader:
 - 1) Contactless smart card technology as defined in FIPS-201.
 - 2) Shall use active/passive proximity detection and shall not require contact with the proximity credential card for operation.
 - a) Active detection proximity card readers shall provide power to compatible credential cards through magnetic induction and receive and decode a unique identification code number transmitted from the credential card.
 - b) Passive detection proximity card readers shall use a swept-frequency, radio frequency field generator to read the resonant frequencies of tuned circuits laminated into compatible credential cards. The resonant frequencies read shall constitute a unique identification code number.
 - 3) Shall read proximity cards in a range from 0 to at least six (6) inches (0 to at least 15 cm) from the reader. The credential card design shall allow for a minimum of 32,000 unique identification codes per facility.
 - 4) Shall be able to read cards from two (2) inches (5cm) to 6 inches (15cm).

5) The operating frequency shall be determined by the type of access control system being utilized.

b. Credential Cards: Shall be in accordance with FIPS 201 and controlled by the PIV enrollment and issuance system.

c. Hirsh Velocity systems

F. Portal Control Devices:

1. Crash Bar:

a. Emergency Exit with Alarm (Panic):

1. Entry control portals shall include panic bar emergency exit hardware as designed.
2. Panic bar emergency exit hardware shall provide an alarm shunt signal to the PACS.
3. The panic bar shall include a conspicuous warning sign with one (1) inch (2.5 cm) high, red lettering notifying personnel that an alarm will be annunciated if the panic bar is operated.
4. Operation of the panic bar hardware shall generate an intrusion alarm that reports to both the SMS and Intrusion Detection System. The use of a micro switch installed within the panic bar shall be utilized for this.
5. The panic bar shall a fully mechanical connection only and shall not depend upon electric power for operation.
6. The panic bar shall be compatible with mortise or rim mount door hardware and shall operate by retracting the bolt manually by either pressing the panic bar or with a key bypass. Refer to Section 2.2.I.9 for key-bypass specifications.

b. Normal Exit:

- 1) Entry control portals shall include panic bar non-emergency exit hardware as designed.
- 2) Panic bar non-emergency exit hardware shall be monitored by and report to the SMS.
- 3) Operation of the panic bar hardware shall not generate a locally audible or an intrusion alarm within the IDS.
- 4) When exiting, the panic bar shall depend upon a mechanical connection only. The exterior, non-secure side of the door shall be provided with an electrified thumb latch or lever to provide access after the credential I.D. authentication by the SMS.

- 5) The panic bar shall be compatible with mortise or rim mount door hardware and shall operate by retracting the bolt manually by either pressing the panic bar or with a key bypass. Refer to Section 2.2.I.9 for key-bypass specifications. The strikes/bolts shall include a micro switch to indicate to the system when the bolt is not engaged or the strike mechanism is unlocked. The signal switches shall report a forced entry to the system in the event the door is left open

G. Entry Control Devices:

1. Shall be hardwired to the PACS main control panel and operated by either a card reader or a biometric device via a relay on the main control panel.
2. Shall be fail-safe in the event of power failure to the PACS system.
3. Shall operate at 24 VCD and be powered by a separate power supply dedicated to the door control system. Each power supply shall be rated to operate a minimum of two doors simultaneously without error to the system or overload the power supply unit.
4. Shall have a diode or metal-oxide varistor (MOV) to protect the controller and power supply from reverse current surges or back-check.
5. Electric Strikes/Bolts: Shall be:
 - a. Made of heavy-duty construction and tamper resistant design.
 - b. Tested to over one million cycles.
 - c. Rated for a minimum of 1000 lbs. holding strength.
 - d. Utilize an actuating solenoid for the strike/bolt. The solenoid shall move from fully open to fully closed position and back in not more than 500 milliseconds and be rated for continuous duty.
 - e. Utilize a signal switch that will indicate to the system if the strike/bolt is not engaged or is unlocked when it should be secured.
 - f. Flush mounted within the door frame.
6. Electric Mortise Locks: Shall be installed within the door and an electric transfer hinge shall be utilized to allow the wires to be transferred from the door frame to the lock. If utilized with a double door then the lock shall be installed inside the active leaf.

7. Electromagnetic Locks:

- a. These locks shall be without mechanical linkage utilizing no moving parts, and securing the door to its frame solely on electromagnetic force.
- b. Shall be comprised of two pieces, the mag-lock and the door plate. The mag-lock shall be surface mounted to the door frame and the door plate shall be surface mounted to the door.
- c. Ensure a diode or MOV is installed in line with the DC voltage supplying power to the unit in order to prevent back-check on the system when the mag-lock is powered.
- d. Shall utilize a magnetic bonding sensor (MBS) to monitor the door status and report that status to the SMS.
- e. Electromagnetic locks shall meet the following minimum technical characteristics:

Operating Voltage		24 VDC
Current Draw		.5A
Holding Force	Swing Doors	1500 lbs (675 Kg)
	Sliding Doors	500 lbs (225 Kg)

H. Wires and Cables

1. Shall meet or exceed the manufactures recommendations for power and signal.
2. Shall be carried in an enclosed conduit system, utilizing electromagnetic tubing (EMT) to include the equivalent in flexible metal, rigid galvanized steel (RGS) to include the equivalent of liquid tight, polyvinylchloride (PVC) schedule 40 or 80.
3. All conduits will be sized and installed per the NEC. All security system signal and power cables that traverse or originate in a high security office space will contained in either EMT or RGS conduit.
4. All conduit, pull boxes, and junction boxes shall be clearly marked every with colored permanent tape or paint that will allow it to be distinguished from all other conduit and infrastructure.
5. Conduit fills shall not exceed 50 percent unless otherwise documented.
6. A pull rope shall be pulled along with signal and power cables to assist in future work.

7. At all locations where core drilling is conducted to allow for conduit to be installed, then fire stopping shall be applied to that area.
8. High power and signal cables shall not share the same conduit and shall be kept separate up to the point of connection. High power for the security system shall be defined as any cable or sets of cables carrying 30 VDC/VAC or higher.
9. Signal Cables:
 - a. Shall meet or exceed all specifications and requirements called out by the manufactures.
 - b. Shall be twisted pairs.
 - c. All cables and conductors, except fiber optic cables, that act as a control, communication, or signal lines shall include surge protection. Surge protection shall be furnished at the equipment end and additional triple electrode gas surge protectors rated for the application on each wire line circuit shall be installed within 3 feet, (1 meter) of the building cable entrance. The inputs and outputs shall be tested in both normal and common mode using the following wave forms:
 - 1) A 10 microsecond rise time by 1000 microsecond pulse width waveform with a peak voltage of 1500 volts and peak current of 60 amperes.
 - 2) An 8 microsecond rise time by 20 microsecond pulse width waveform with a peak voltage of 1000 volts and peak current of 500 amperes.
10. Power Cables:
 - a. Shall be rated for either 110 or 220 VAC, 50 or 60 Hz, and shall comply with VAMC Master Spec 26 05 21 Low Voltage Electrical Power Conductors and Cables (600 Volts and Below).
 - b. Shall be sized according and comply with the NEC. High voltage power cables will be a minimum of three conductors, 14 AWG, stranded, and coated with a non-conductive polyvinylchloride (PVC) jacket.
 - c. Low Voltage Power Cables:
 - 1) All cables shall be a minimum of 18 AWG, Stranded and have a polyvinylchloride outer jacket.

2) Specific cable size shall be determined using a basic voltage over distance calculation and shall comply with the NEC's requirements for low voltage cables.

d. All equipment connected to AC power shall be protected from surges. Equipment protection shall withstand surge test waveforms described in IEEE C62.41. Fuses shall not be used as a means of surge protection.

2.3 INSTALLATION KIT

A. General: The kit shall be provided that at a minimum includes all connectors and terminals, labeling systems, audio spade lugs, barrier strips, punch blocks or wire wrap terminals, heat shrink tubing, cable ties, solder, hangers, clamps, bolts, conduit, cable duct, and/or cable tray, etc., required to accomplish a neat and secure installation. All wires shall terminate in a spade lug and barrier strip, wire wrap terminal or punch block. Unfinished or unlabeled wire connections shall not be allowed. All unused and partially opened installation kit boxes, coaxial, fiber-optic, and twisted pair cable reels, conduit, cable tray, and/or cable duct bundles, wire rolls, physical installation hardware shall be turned over to the Contracting Officer's Technical Representative (COT). The following sections outlined are the minimum required installation sub-kits:

1. System Grounding:

a. The grounding kit shall include all cable and installation hardware required. All head end equipment and power supplies shall be connected to earth ground via internal building wiring, according to the NEC.

b. This includes:

- 1) Coaxial Cable Shields
- 2) Control Cable Shields
- 3) Data Cable Shields
- 4) Equipment Racks
- 5) Equipment Cabinets
- 6) Conduits
- 7) Cable Duct blocks
- 8) Cable Trays
- 9) Power Panels

10) Grounding

11) Connector Panels

2. Coaxial Cable: The coaxial cable kit shall include all coaxial connectors, cable tying straps, heat shrink tabbing, hangers, clamps, etc., required to accomplish a neat and secure installation.
3. Wire and Cable: The wire and cable kit shall include all connectors and terminals, audio spade lugs, barrier straps, punch blocks, wire wrap strips, heat shrink tubing, tie wraps, solder, hangers, clamps, labels etc., required to accomplish a neat and orderly installation.
4. Conduit, Cable Duct, and Cable Tray: The kit shall include all conduit, duct, trays, junction boxes, back boxes, cover plates, feed through nipples, hangers, clamps, other hardware required to accomplish a neat and secure conduit, cable duct, and/or cable tray installation in accordance with the NEC and this document.
5. Equipment Interface: The equipment kit shall include any item or quantity of equipment, cable, mounting hardware and materials needed to interface the systems with the identified sub-system(s) according to the OEM requirements and this document.
6. Labels: The labeling kit shall include any item or quantity of labels, tools, stencils, and materials needed to label each subsystem according to the OEM requirements, as-installed drawings, and this document.
7. Documentation: The documentation kit shall include any item or quantity of items, computer discs, as installed drawings, equipment, maintenance, and operation manuals, and OEM materials needed to provide the system documentation as required by this document and explained herein.

PART 3

3.1 INSTALLATION

- A. System installation shall be in accordance with UL 294, manufacturer and related documents and references, for each type of security subsystem designed, engineered and installed.
- B. Components shall be configured with appropriate "service points" to pinpoint system trouble in less than 30 minutes.

- C. The Contractor shall install all system components including Government furnished equipment, and appurtenances in accordance with the manufacturer's instructions, documentation listed in Sections 1.4 and 1.5 of this document, and shall furnish all necessary connectors, terminators, interconnections, services, and adjustments required for a operable system.
- D. The extension of the existing PACS will be designed, engineered, installed, and tested to ensure all components are fully compatible as a system and can be integrated with all associated security subsystems, whether the system is a stand alone or a network.
- E. For integration purposes, the PACS shall be integrated where appropriate with the following associated security subsystem:
 - 1. IDS:
 - a. Be able monitor door control sensors.
 - b. Be able to monitor and control the IDS on a 24 hours basis.
 - c. Be programmed to go into an alarm state when an IDS device is put into an alarm state, and notify the operator via an audible alarm.
 - d. For additional PACS system requirements as they relate to the IDS, refer to Section 28 16 11, INTRUSION DETECTION SYSTEM.
- F. Integration with this security subsystem shall be achieved by direct hardwiring of the systems.
- G. For programming purposes refer to the manufacturers requirements for correct system operations. Ensure computers being utilized for system integration meet or exceed the minimum system requirements outlined on the systems software packages.
- H. The Contractor shall visit the site and verify that site conditions are in agreement with the design package. The Contractor shall report all changes to the site or conditions that will affect performance of the system. The Contractor shall not take any corrective action without written permission from the Government.
- I. The Contractor shall visit the site and verify that site conditions are in agreement/compliance with the design package. The Contractor shall report all changes to the site or conditions that will affect performance of the system to the Contracting Officer's Technical Representative (COT) in the form of a report. The Contractor shall not take any corrective action without written permission received from the Contracting Officer's Technical Representative (COT).

J. Existing Equipment:

1. The Contractor shall connect to and utilize existing door equipment, control signal transmission lines, and devices as outlined in the design package. Door equipment and signal lines that are usable in their original configuration without modification may be reused with Contracting Officer's Technical Representative's (COT) approval.
2. The Contractor shall perform a field survey, including testing and inspection of all existing door equipment and signal lines intended to be incorporated into the PACS, and furnish a report to the Contracting Officer's Technical Representative (COT) as part of the site survey report. For those items considered nonfunctioning, provide (with the report) specification sheets, or written functional requirements to support the findings and the estimated cost to correct the deficiency. As part of the report, the Contractor shall include a schedule for connection to all existing equipment.
3. The Contractor shall make written requests and obtain approval prior to disconnecting any signal lines and equipment, and creating equipment downtime. Such work shall proceed only after receiving Contracting Officer's Technical Representative's (COT) approval of these requests. If any device fails after the Contractor has commenced work on that device, signal or control line, the Contractor shall diagnose the failure and perform any necessary corrections to the equipment.
4. The Contractor shall be held responsible for repair costs due to Contractor negligence, abuse, or improper installation of equipment.
5. The Contracting Officer's Technical Representative (COT) shall be provided a full list of all equipment that is to be removed or replaced by the Contractor, to include description and serial/manufacturer numbers where possible. The Contractor shall dispose of all equipment that has been removed or replaced based upon approval of the Contracting Officer's Technical Representative (COT) after reviewing the equipment removal list. In all areas where equipment is removed or replaced the Contractor shall repair those areas to match the current existing conditions.

- K. Enclosure Penetrations: All enclosure penetrations shall be from the bottom of the enclosure unless the system design requires penetrations from other directions. Penetrations of interior enclosures involving transitions of conduit from interior to exterior, and all penetrations on exterior enclosures shall be sealed with rubber silicone sealant to preclude the entry of water and will comply with VAMC Master Specification 07 84 00, Firestopping. The conduit riser shall terminate in a hot-dipped galvanized metal cable terminator. The terminator shall be filled with an approved sealant as recommended by the cable manufacturer and in such a manner that the cable is not damaged.
- L. Cold Galvanizing: All field welds and brazing on factory galvanized boxes, enclosures, and conduits shall be coated with a cold galvanized paint containing at least 95 percent zinc by weight.
- M. Control Panels:
1. Connect power and signal lines to the controller.
 2. Program the panel as outlined by the design and per the manufacturer's programming guidelines.
- N. SMS:
1. Coordinate with the VAMC agency's IT personnel to place the computer on the local LAN or Intranet and provide the security system protection levels required to insure only authorized VAMC personnel have access to the system.
 2. Program and set-up the SMS to ensure it is in fully operation.
- O. Card Readers:
1. Connect all signal inputs and outputs as shown and specified.
 2. Terminate input signals as required.
 3. Program and address the reader as per the design package.
 4. Readers shall be surface or flushed mounted and all appropriate hardware shall be provided to ensure the unit is installed in an enclosed conduit system.
- P. Portal Control Devices:
1. Install all signal input and output cables as well as all power cables.
 2. Devices shall be surface or flush mounted as per the design package.
 3. Program all devices and ensure they are working.
- Q. Door Status Indicators:
1. Install all signal input and output cables as well as all power cables.

2. RTE's shall be surface mounted and angled in a manner that they cannot be compromised from the non-secure side of a windowed door, or allow for easy release of the locking device from a distance no greater than 6 feet from the base of the door.
3. Door position sensors shall be surface or flush mounted and wide gap with the ability to operate at a maximum distance of up to 2" (5 cm).

R. Entry Control Devices:

1. Install all signal input and power cables.
2. Strikes and bolts shall be mounted within the door frame.
3. Mortise locks shall be mounted within the door and an electric transfer hinge shall be utilized to transfer the wire from within the door frame to the mortise lock inside the door.
4. Electromagnetic locks shall be installed with the mag-lock mounted to the door frame and the metal plate mounted to the door.

S. System Start-Up:

1. The Contractor shall not apply power to the PACS until the following items have been completed:
 - a. PACS equipment items and have been set up in accordance with manufacturer's instructions.
 - b. A visual inspection of the PACS has been conducted to ensure that defective equipment items have not been installed and that there are no loose connections.
 - c. System wiring has been tested and verified as correctly connected as indicated.
 - d. All system grounding and transient protection systems have been verified as installed and connected as indicated.
 - e. Power supplies to be connected to the PACS have been verified as the correct voltage, phasing, and frequency as indicated.
2. Satisfaction of the above requirements shall not relieve the Contractor of responsibility for incorrect installation, defective equipment items, or collateral damage as a result of Contractor work efforts.

T. Supplemental Contractor Quality Control:

1. The Contractor shall provide the services of technical representatives who are familiar with all components and installation procedures of the installed PACS; and are approved by the Contracting Officer's Technical Representative (COT).

2. The Contractor will be present on the job site during the preparatory and initial phases of quality control to provide technical assistance.
3. The Contractor shall also be available on an as needed basis to provide assistance with follow-up phases of quality control.
4. The Contractor shall participate in the testing and validation of the system and shall provide certification that the system installed is fully operational as all construction document requirements have been fulfilled.

3.2 TESTING AND TRAINING

All testing and training shall be compliant with the VAMC General Requirements, Section 01 00 00, GENERAL REQUIREMENTS.

-----END-----

**SECTION 28 16 11
INTRUSION DETECTION SYSTEM**

PART 1 - GENERAL

1.1 DESCRIPTION

Provide and install an extension of the existing Intrusion Detection System, hereinafter referred to as IDS, as specified in this section.

1.2 RELATED WORK

- A. For firestopping application and use, Section 07 84 00, FIRESTOPPING.
- B. For window installation, Section 08 51 13, ALUMINUM WINDOWS.
- C. For door installation, Section 08 71 00, DOOR HARDWARE.
- D. For electrical installation, Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- E. For power cables, Section 26 05 21, LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW).
- F. For grounding of equipment, Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.
- G. For infrastructure, Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS.
- H. For access control integration, Section 28 13 11, PHYSICAL ACCESS CONTROL SYSTEMS (PACS).
- I. For Warranty Construction, see GENERAL REQUIREMENTS.
- J. For General Requirements, Section 01 00 00, GENERAL REQUIREMENTS.

1.3 QUALITY ASSURANCE

- A. The Contractor shall be responsible for providing, installing, and the operation of the IDS as shown. The Contractor shall also provide certification as required.
- B. The security system shall be installed and tested to ensure all components are fully compatible as a system and can be integrated with all associated security subsystems, whether the security system is stand-alone or a part of a complete Information Technology (IT) computer network.
- C. The Contractor or security sub-contractor shall be a licensed security Contractor as required within the state or jurisdiction of where the installation work is being conducted.

1.4 SUBMITTALS

- A. Submit below items in conjunction with Master Specification Sections 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, and Section 02 41 00, DEMOLITION.

- B. Provide certificates of compliance with Section 1.3, Quality Assurance.
- C. Provide a pre-installation and as-built design package in both electronic format and on paper, minimum size 48 x 48 inches (1220 x 1220 millimeters); drawing submittals shall be per the established project schedule.
- D. Pre-installation design and as-built packages shall include:
 - 1. Index Sheet that shall:
 - a. Define each page of the design package to include facility name, building name, floor, and sheet number.
 - b. Provide a list of all security abbreviations and symbols.
 - c. Reference all general notes that are utilized within the design package.
 - d. Specification and scope of work pages for all security systems that are applicable to the design package that will:
 - 1) Outline all general and job specific work required within the design package.
 - 2) Provide a device identification table outlining device Identification (ID) and use for all security systems equipment utilized in the design package.
 - 2. Drawing sheets that will be plotted on the individual floor plans or site plans shall:
 - a. Include a title block as defined above.
 - b. Define the drawings scale in both standard and metric measurements.
 - c. Provide device identification and location.
 - d. Address all signal and power conduit runs and sizes that are associated with the design of the electronic security system and other security elements (e.g., barriers, etc.).
 - e. Identify all pull box and conduit locations, sizes, and fill capacities.
 - f. Address all general and drawing specific notes for a particular drawing sheet.

3. A riser drawing for each applicable security subsystem shall:
 - a. Indicate the sequence of operation.
 - b. Relationship of integrated components on one diagram.
 - c. Include the number, size, identification, and maximum lengths of interconnecting wires.
 - d. Wire/cable types shall be defined by a wire and cable schedule.
The schedule shall utilize a lettering system that will correspond to the wire/cable it represents (example: A = 18 AWG/1 Pair Twisted, Unshielded). This schedule shall also provide the manufacturer's name and part number for the wire/cable being installed.
4. A system drawing for each applicable security system shall:
 - a. Identify how all equipment within the system, from main panel to device, shall be laid out and connected.
 - b. Provide full detail of all system components wiring from point-to-point.
 - c. Identify wire types utilized for connection, interconnection with associate security subsystems.
 - d. Show device locations that correspond to the floor plans.
 - e. All general and drawing specific notes shall be included with the system drawings.
5. A schedule for all of the applicable security subsystems shall be included. All schedules shall provide the following information:
 - a. Device ID.
 - b. Device Location (e.g. site, building, floor, room number, location, and description).
 - c. Mounting type (e.g. flush, wall, surface, etc.).
 - d. Power supply or circuit breaker and power panel number.
 - e. In addition, for the IDS, provide the sensor ID, sensor type and housing model number.
6. Detail and elevation drawings for all devices that define how they were installed and mounted.
- E. Pre-installation design packages shall be reviewed by the Contractor along with a VAMC Representative (COR) to ensure all work has been clearly defined and completed. All reviews shall be conducted in accordance with the project schedule. There shall be one (1) stage to the review process:
 1. 100 percent

- F. Provide manufacturer security system product cut-sheets. Submit for approval at least 30 days prior to commencement of formal testing, a Security System Operational Test Plan. Include procedures for operational testing of each component and security subsystem, to include performance of an integrated system test.
- G. Submit manufacture's certification of Underwriters Laboratories, Inc. (UL) listing as specified. Provide all maintenance and operating manuals per the VAMC General Requirements, Section 01 00 00, GENERAL REQUIREMENTS.

1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below (including amendments, addenda, revisions, supplement, and errata) form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American National Standards Institute (ANSI)/Security Industry Association (SIA):
 - PIR-01-00.....Passive Infrared Motion Detector Standard -
Features for Enhancing False Alarm Immunity
 - CP-01-00Control Panel Standard-Features for False Alarm
Reduction
- C. Department of Justice American Disability Act (ADA)
 - 28 CFR Part 36-90.....ADA Standards for Accessible Design
- D. National Electrical Manufacturers Association (NEMA):
 - 250-03.....Enclosures for Electrical Equipment (1000 Volts
Maximum)
- E. National Fire Protection Association (NFPA):
 - 70-11.....National Electrical Code
 - 731-06.....Standards for the Installation of Electric
Premises Security Systems
- F. Underwriters Laboratories, Inc. (UL):
 - 464-03.....Audible Signal Appliances
 - 609-96.....Local Burglar Alarm Units and Systems
 - 634-00.....Standards for Connectors with Burglar-Alarm
Systems
 - 639-97.....Standards for Intrusion Detection Units
 - 1037-99.....Standard for Anti-theft Alarms and Devices
 - 1635-96.....Digital Alarm Communicator System Units
- G. Uniform Federal Accessibility Standards (UFAS), 1984

1.6 WARRANTY OF CONSTRUCTION.

Warrant IDS work subject to the Article "Warranty of Construction" of FAR 52.246-21.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS

A. General

1. All equipment associated within the IDS shall be rated for continuous operation. Environmental conditions (i.e. temperature, humidity, wind, and seismic activity) shall be taken under consideration at each facility and site location prior to installation of the equipment.
2. All equipment shall operate on a 120 or 208 volts alternating current (VAC); 60 Hz AC power system unless documented otherwise in subsequent sections listed within this specification. All equipment shall have a back-up source of power that will provide a minimum of 96 hours of run time in the event of a loss of primary power to the facility.
3. The system shall be designed, installed, and programmed in a manner that will allow for ease of operation, programming, servicing, maintenance, testing, and upgrading of the system.
4. All equipment and materials for the system will be compatible to ensure functional operation in accordance with requirements.

2.2 EQUIPMENT ITEMS

A. General:

1. All requirements listed below are the minimum specifications that need to be met in order to comply with the IDS.
2. All IDS sensors shall conform to UL 639, Intrusion Detection Standard.
3. Ensure that IDS is fully integrated with other security subsystems as required to include, but not limited to PACS and Access Control System and Database Management. The IDS provided shall not limit the expansion and growth capability to a single manufacturer and shall allow modular expansion with minimal equipment modifications.

B. IDS Components: The IDS shall consist of, but not be limited to, the following components:

1. Control Panel
2. Interior Detection Devices (Sensors)

3. Power Supply

4. Enclosures

- C. Control Panel:

1. The Control panel shall be the main point of programming, monitoring, accessing, securing, and troubleshooting the IDS. Refer to American National Standards Institute (ANSI) CP-01 Control Panel Standard-Features for False Alarm Reduction.
2. The Control Panel shall provide a means of reporting alarms to an existing Access Control System and Database Management via a direct connection to an alarm control monitoring panel.
3. The Control panel shall utilize a Multifunctional Keypad, Input and Output Modules for expansion of alarm zones, interfacing with additional security subsystems, programming, monitoring and controlling the IDS.
4. The Control panel shall meet or exceed the following minimum functional requirements for programming outputs, system response, and user interface:
 - a. Programming Outputs:
 - 1) 2 Amps (A) alarm power at 12 VDC
 - 2) 1.4 A auxiliary power at 12 VDC
 - 3) Four alarm output patterns
 - 4) Programmable bell test
 - 5) Programmable bell shut-off timer
 - b. System Response:
 - 1) Selectable point response time
 - 2) Cross point capability
 - 3) Alarm verification
 - 4) Watch mode
 - 5) Scheduled events arm, disarm, bypass and un-bypass points, control relays, and control authority levels
 - c. User Interface:
 - 1) Supervises up to eight command points (e.g. Up to 16 unsupervised keypads can be used)
 - 2) Provides custom keypad text
 - 3) Addresses full function command menu including custom functions

- 4) Allows user authority by defined area and 16-character name
- 5) Provides for 14 custom authority control levels allowing user's authority to change, add, delete pass codes, disarm, bypass points, and start system tests.

5. The Control panel shall meet or exceed the following technical characteristics:

Input Voltage via 110 VAC or 220 VAC Step-down Transformer	16 or 18 VAC
Operating Voltage	12 VDC
Output Voltage	12 VDC @ 2 A max
Direct Hardwire Zones	7
Partitions	8
Multifunctional Keypads	16 (2 per partition)
Communications Port	RJ-11

6. An input module shall be utilized to connect additional detection devices to the control panel. This module will meet or exceed the following technical characteristics:

Operating Voltage	8.5 to 14.5 VDC Nominal
Zone Inputs	Style A (Class B) Supervised
Operating Temperature	32 to 140 degrees F (0 to 40 degrees C)

7. An output module shall be utilized to interface the control panel with other security subsystems. The output module shall meet or exceed the following technical characteristics:

Operating Voltage	8.5 to 14.5 VDC Nominal
Output Relays	"Form C" Dry Relay Contracts
Relay Contact Rating	4A @ 24 VDC
	4A @ 24 VAC
	1A @ 70 VAC
Operating Temperature	32 to 140 degrees F (0 to 40 degrees C)

8. The control panel shall have a communications port that will allow for communications with a computer for programming, monitoring, and troubleshooting purposes. The communications port will be, at a minimum, and RJ-11 or better.

9. The control panel will have a systems success probability of 95% or better, and shall include the following success considerations:
 - a. False Alarm: Shall not exceed one (1) false alarm per 30 days per sensor zone.
 - b. Nuisance Alarm: Shall not exceed a rate of one (1) alarm per seven (7) days per zone within the first 60 days after installation and acceptance. Sensor adjustments will be made and then shall not exceed one (1) alarm per 30 days.
 10. The Control Panel will be able to detect either a line fault or power loss for all supervised data cables.
 - a. Line Fault Detection: Communication links of the IDS shall have an active mode for line fault detection. Fault isolation at the systems level shall have the same geographic resolutions as provided for intrusion detection. The line fault alarm shall be clearly distinguishable from other alarms.
 - b. Power Loss Detection: Provide the capability to detect when critical components experience temporary or permanent loss of power and annunciate to clearly identify the component experiencing power loss.
- D. Interior Detection Devices: (Sensors)
1. The IDS shall consist of interior, exterior, and other detection devices that are capable of:
 - a. Locating intrusions at individually protected asset areas or at an individual portal;
 - b. Locating intrusions within a specific area of coverage;
 - c. Locating failures or tampering of individual sensors or components.
 2. Provide and adjust for devices so that coverage is maximized in the space or area it is installed in. For large rooms where multiple devices are required, ensure device coverage is overlapping.
 3. Detection sensitivity shall be set up to ensure maximum coverage of the secure area is obtained while at the same time limiting excessive false alarms due to the environment and impact of small animals. All detection devices shall be anti-masking with exception of video motion detection.
 4. Dual sensor technology shall be used when possible. Sensor technology shall not be of the same type that is easily defeated by a single method. This will reduce the amount of false alarms.

5. Interior Environmental Conditions: Systems shall be able to operate in environmentally protected interior areas and shall meet operational performance requirements for the following ambient conditions:

- a. If components are installed in unheated areas they shall be able to operate in temperatures as low as 0 F (-17 C);
- b. Interior Sensor Environmental Characteristics:

Temperatures	32F to 120 F (0 to 50 C)
Pressure	Sea Level to 15,000 ft. (4573m) above sea level
Humidity	5% - 95%
Fungus	Components of non-fungus nutrient materials
Acoustical Noise	Suitable for high noise environments above 100db

6. Balanced Magnetic Switches (BMS)

- a. BMS switches shall be surface or recessed mounted according to manufacturer's instructions. Recessed mounted is the preferred method to reduce tampering or defeating of the system. Switches shall activate when a disturbance in the balanced magnetic field occurs.
- b. Switches shall have a minimum of two (2) encapsulated reed switches.
- c. Contractor shall provide each BMS with a current protective device, rated to limit current to 80% of the switch capacity.
- d. Surface Mounted BMS: For exterior application, components shall be housed in weatherproof enclosures.
- e. BMS field adjustments in the fixed space between magnet and switch housing shall not be possible. Attempts to adjust or disturb the magnetic field shall cause a tamper alarm.
- f. BMS Technical Characteristics:

Maximum current	.25 amperes
Maximum voltage	30 VDC
Maximum power	3.0 W (without internal terminating resistors). 1.0 W (with internal terminating resistors).

Components	Three (3) pre-adjusted reed switches Three (3) pre-adjusted magnets
Output contacts	Transfer type SPDT
Contact rating	0.5 amperes, 28 VDC
Switch mechanism	Internally adjustable ¼ - ½ in. (6-13 mm)
Wiring	Two (2) wires #22 American Wire Gauge (AWG), three (3) or 11 foot attached cable
Activation lifetime	1,000,000 activations
Enclosure	Nonferrous materials
Tamper alarm activation	Cover opened 1/8 in. (3 mm) and inaccessible until actuated

7. Tamper Alarm Switches: The following IDS sensors shall be used to monitor and detect potential tampering of sensors, control panels and enclosures.
- a. Tamper Switches: All enclosures including cabinets, housings, boxes, raceways, and fittings with hinged doors or removable covers containing circuits and power supplies related to the IDS shall include corrosion-resistant tamper switches.
 - b. Tamper alarms shall be annunciated to be clearly distinguishable from IDS alarms.
 - c. Tamper switches will not be in a viewable from a direct line of sight perspective. The minimum amount of time the tamper switch becomes active and sends a signal after an enclosure is opened or panel removable is attempted, shall be one (1) second.
 - d. Tamper switches will initiate when enclosure doors or covers is removed as little as 1/4 in. (6.35 mm) from the closed position unless otherwise indicated. Tamper switches shall be:
 - 1) Push/pull automatic reset type;
 - 2) Inaccessible until switch is activated;
 - 3) Spring-loaded and held in closed position by door or cover; and
 - 4) Wired to break a circuit when door or cover is removed with each sensor annunciated individually at a central reporting processor.

- e. Fail-Safe Mode: Shall provide the capability to detect and annunciate diminished functional capabilities and perform self-tests. Fail-safe alarms shall be annunciated to be clearly distinguishable from other types of alarms.

E. Power Supply

1. A power supply shall only be utilized if the control panel is unable to support the load requirements of the IDS system.
2. All power supplies shall be UL rated and able to adequately power two entry control devices on a continuous base without failure.
3. Power supplies shall meet the following minimum technical characteristics:

INPUT POWER	110 VAC 60 HZ 2 amp
OUTPUT VOLTAGE	12 VDC Nominal (13.8 VDC) 24 VDC Nominal (27.6 VDC) Filtered and Regulated
BATTERY	Dependant on Output Voltage shall provide up to 14 Ah, rechargeable
OUTPUT CURRENT	4 amp max. @ 13.8 VDC 3 amp max. @ 27.6 VDC
BATTERY FUSE SIZE	3.5 A @ 250 VAC
CHARGING CIRCUIT	Built-in standard

F. Enclosures:

1. All control panels, input and output modules, and power supplies shall be housed inside a metal enclosure in accordance with National Electrical Manufacturers Association (NEMA) 250 Enclosures for Electrical Equipment.
2. The enclosure shall be UL rated, lockable and alarmed with a tamper alarm switch that is monitored by the control panel.
3. The enclosures will be NEMA 4 rated if exterior mounted.
4. All connections to the enclosure shall meet or exceed the requirements set forth in the NEC.

2.3 INSTALLATION KIT

A. General

1. The kit shall be provided that, at a minimum, includes all connectors and terminals, labeling systems, audio spade lugs, barrier strips, punch blocks or wire wrap terminals, heat shrink tubing, cable ties, solder, hangers, clamps, bolts, conduit, cable

duct, and/or cable tray, etc., required to accomplish a neat and secure installation. All wires shall terminate in a spade lug and barrier strip, wire wrap terminal or punch block. Unfinished or unlabeled wire connections shall not be allowed. All unused and partially opened installation kit boxes, coaxial, fiber-optic, and twisted pair cable reels, conduit, cable tray, and/or cable duct bundles, wire rolls, physical installation hardware shall be turned over to the Contracting Officer's Technical Representative (COR). The following sections outline the minimum required installation sub-kits to be used:

2. System Grounding
 - a. The grounding kit shall include all cable and installation hardware required. All head end equipment and power supplies shall be connected to earth ground via internal building wiring, according to the NEC.
 - b. This includes, but is not limited to:
 - 1) Coaxial Cable Shields
 - 2) Control Cable Shields
 - 3) Data Cable Shields
 - 4) Equipment Racks
 - 5) Equipment Cabinets
 - 6) Conduits
 - 7) Cable Duct blocks
 - 8) Cable Trays
 - 9) Power Panels
 - 10) Grounding
 - 11) Connector Panels
3. Coaxial Cable: The coaxial cable kit shall include all coaxial connectors, cable tying straps, heat shrink tabbing, hangers, clamps, etc., required to accomplish a neat and secure installation.
4. Wire and Cable: The wire and cable kit shall include all connectors and terminals, audio spade lugs, barrier straps, punch blocks, wire wrap strips, heat shrink tubing, tie wraps, solder, hangers, clamps, labels etc., required to accomplish a neat and orderly installation.

5. Conduit, Cable Duct, and Cable Tray: The kit shall include all conduit, duct, trays, junction boxes, back boxes, cover plates, feed through nipples, hangers, clamps, other hardware required to accomplish a neat and secure conduit, cable duct, and/or cable tray installation in accordance with the NEC and this document.
6. Equipment Interface: The equipment kit shall include any item or quantity of equipment, cable, mounting hardware and materials needed to interface the systems with the identified sub-system(s) according to the OEM requirements and this document.
7. Labels: The labeling kit shall include any item or quantity of labels, tools, stencils, and materials needed to label each subsystem according to the OEM requirements, as-installed drawings, and this document.
8. Documentation: The documentation kit shall include any item or quantity of items, computer discs, as installed drawings, equipment, maintenance, and operation manuals, and OEM materials needed to correctly provide the system documentation as required by this document and explained herein.

PART 3 EXECUTION

3.1 INSTALLATION

- A. IDS installation shall be in accordance with Underwriters Laboratories (UL) 639 Standards for Intrusion Detection Units and UL 634 Standards for Connectors with Burglar Alarm Systems, and appropriate manufacture's installation manuals for each type of IDS.
- B. Components shall be configured with appropriate "service points" to pinpoint system trouble in less than 30 minutes.
- C. The Contractor shall install all system components including VAMC furnished equipment, and appurtenances in accordance with the manufacturer's instructions and shall furnish all necessary connectors, terminators, interconnections, services, and adjustments required for a complete and operable system.
- D. The IDS will be designed, engineered, installed, and tested to ensure all components are fully compatible as a system and can be integrated with all associated security subsystems, whether the system is a stand alone or designed as a computer network.

- E. The IDS shall be able to be integrated with other security subsystems. Integration with these security subsystems shall be achieved by computer programming and the direct hardwiring of the systems. Determination for methodology shall be outlined when the system(s) is/are being designed and engineered. For installation purposes, the IDS shall utilize an output module for integration with other security subsystems. The Contractor will ensure all connections are per the OEM and that any and all software upgrades required to integrate the systems are installed prior to system start-up.
- F. For programming purposes, the Contractor shall refer to the manufacturer's requirements and Contracting Officer's Technical Representative (COR) instructions for correct system operations. This includes ensuring computers being utilized for system integration meet or exceeds the minimum system requirements outlined in the IDS software packages.
- G. Lightning and power surges to the central alarm reporting and display unit shall be protected at both ends against excessive voltages. This requirement shall apply for circuits that are routed both in underground conduits and overhead runs.
- H. At a minimum, the Contractor shall install primary detection devices, such as three electrode gas-type surge arresters, and secondary protectors to reduce dangerous voltages to levels that will cause no damage. Fuses shall not be permitted as protection devices.
- I. The Contractor shall provide fail-safe gas tube type surge arresters on exposed IDS data circuits. In addition, transient protection shall protect against spikes up to 1000 volts peak voltage with a one-microsecond rise time and 100-microsecond decay time, without causing false alarms. The protective device shall be automatic and self-restoring. Also, circuits shall be designed or selected assuming a maximum of 25 ohms to ground.
- J. Product Delivery, Storage and Handling:
1. Delivery: Deliver materials to the job site in OEM's original unopened containers, clearly labeled with the OEM's name, equipment model and serial identification numbers, and UL logo. The Contracting Officer's Technical Representative (COR) may inventory the IDS equipment at the time of delivery and reject items that do not conform to this requirement.

2. Storage and Handling: Store and protect equipment in a manner that will preclude damage as directed by the Contracting Officer's Technical Representative (COR).

K. Cleaning and Adjustments:

1. Cleaning: Subsequent to installation, clean each system component of dust, dirt, grease, or oil incurred during installation in accordance to manufacture instructions.
2. Prepare for system activation by following manufacturer's recommended procedures for adjustment, alignment, or synchronization. Prepare each component in accordance with appropriate provisions of the component's installation, operations, and maintenance instructions.

L. Tamper Switches

1. Install tamper switches to initiate an alarm signal when a panel, box, or component housing door or cover is moved as little as 6.35 mm 1/4 inch from the normally closed position unless otherwise specified.
2. Locate tamper switches within enclosures, cabinets, housings, boxes, raceways, and fittings to prevent direct line of sight to any internal components and to prevent tampering with switch or circuitry.
3. Conceal tamper switch mounting hardware so that the location of the switch within the enclosure cannot be determined from the exterior.

M. Unique IDS Installation Components:

1. BMS Surface Mounted:
 - a. Surface mounted BMS housing for the switch element shall have the capability to receive threaded conduit. Housing covers for surface mounted BMS, if made of cast aluminum, shall be secured by stainless steel screws. Magnet housing cover shall not be readily removable and BMS housings shall be protected from unauthorized access by a cover operated, corrosion-resistant tamper device.
 - b. Conductors running from a door to alarm circuits shall be contained within a flexible armored cord constructed from corrosion-resistant metal. Each end of the armored cord shall terminate in a junction box or other enclosure. Armored cord ends shall be mechanically secured to the junction boxes by clamps or bushings. Conductors within the armored cord shall be provided

with lug terminals at each end. Conductors and the armored cord shall experience no mechanical strain as the door is removed from fully open to closed position. Switch circuits shall initiate an alarm if a short circuit is applied to the door cord.

2. BMS Recessed Mounted:

- a. Ball bearing door trips shall be mounted within vault door headers such that when the locking mechanism is secured, the door bolt engages an actuator, mechanically closing the switch.
- b. Door bolt locking mechanisms shall be fully engaged before the ball bearing door trip is activated. Also, circuit jumpers from the door shall be provided.

3.2 TESTS AND TRAINING

All testing and training shall be compliant with the VAMC General Requirements, Section 01 00 00, GENERAL REQUIREMENTS.

-----END----

**SECTION 28 23 00
VIDEO SURVEILLANCE**

PART 1 - GENERAL

1.1 DESCRIPTION

Provide and install an extension to the existing Video Surveillance System, which is identified as the Closed Circuit Television System hereinafter referred to as the CCTV System as specified in this section.

1.2 RELATED WORK

- A. For firestopping application and use, Section 07 84 00, FIRESTOPPING.
- B. For labeling and signs, Section 10 14 00, SIGNAGE.
- C. For connection of high voltage, Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- D. For power cables, Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW).
- E. For grounding of equipment, Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.
- F. For infrastructure, Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS.
- G. For access control, Section 28 13 11, PHYSICAL ACCESS CONTROL SYSTEMS (PACS).
- H. For alarm systems, Section 28 16 11, INTRUSION DETECTION SYSTEM (IDS).
- I. For General Requirements, Section 01 00 00, GENERAL REQUIREMENTS.

1.3 QUALITY ASSURANCE

- A. The Contractor shall be responsible for providing, installing, and the operation of the CCTV System as shown. The Contractor shall also provide certification as required.
- B. The security system shall be installed and tested to ensure all components are fully compatible as a system and can be integrated with all associated security subsystems, whether the security system is stand-alone or a part of a complete Information Technology (IT) computer network.
- C. The Contractor or security sub-contractor shall be a licensed security Contractor as required within the state or jurisdiction of where the installation work is being conducted.

1.4 SUBMITTALS

- A. Submit below items in conjunction with Master Specification Sections 01 33 23, Shop Drawings, Product Data, and Samples, and Section 02 41 00, Demolition Drawings.
- B. Provide certificates of compliance with Section 1.3, Quality Assurance.
- C. Provide a pre-installation and as-built design package in both electronic format and on paper, minimum size 48 x 48 inches (1220 x 1220 millimeters); drawing submittals shall be per the established project schedule.
- D. Pre-installation design and as-built packages shall include:
 - 1. Index Sheet that shall:
 - a. Define each page of the design package to include facility name, building name, floor, and sheet number.
 - b. Provide a list of all security abbreviations and symbols.
 - c. Reference all general notes that are utilized within the design package.
 - d. Specification and scope of work pages for all security systems that are applicable to the design package that will:
 - 1) Outline all general and job specific work required within the design package.
 - 2) Provide a device identification table outlining device Identification (ID) and use for all security systems equipment utilized in the design package.
 - 2. Drawing sheets that will be plotted on the individual floor plans or site plans shall:
 - a. Include a title block as defined above.
 - b. Define the drawings scale in both standard and metric measurements.
 - c. Provide device identification and location.
 - d. Address all signal and power conduit runs and sizes that are associated with the design of the electronic security system and other security elements (e.g., barriers, etc.).
 - e. Identify all pull box and conduit locations, sizes, and fill capacities.
 - f. Address all general and drawing specific notes for a particular drawing sheet.

3. A riser drawing for each applicable security subsystem shall:
 - a. Indicate the sequence of operation.
 - b. Relationship of integrated components on one diagram.
 - c. Include the number, size, identification, and maximum lengths of interconnecting wires.
 - d. Wire/cable types shall be defined by a wire and cable schedule.
The schedule shall utilize a lettering system that will correspond to the wire/cable it represents (example: A = 18 AWG/1 Pair Twisted, Unshielded). This schedule shall also provide the manufacturer's name and part number for the wire/cable being installed.
4. A system drawing for each applicable security system shall:
 - a. Identify how all equipment within the system, from main panel to device, shall be laid out and connected.
 - b. Provide full detail of all system components wiring from point-to-point.
 - c. Identify wire types utilized for connection, interconnection with associate security subsystems.
 - d. Show device locations that correspond to the floor plans.
 - e. All general and drawing specific notes shall be included with the system drawings.
5. A schedule for all of the applicable security subsystems shall be included. All schedules shall provide the following information:
 - a. Device ID.
 - b. Device Location (e.g. site, building, floor, room number, location, and description).
 - c. Mounting type (e.g. flush, wall, surface, etc.).
 - d. Power supply or circuit breaker and power panel number.
 - e. In addition, for the CCTV Systems, provide the camera ID, camera type (e.g. fixed or pan/tilt/zoom (P/T/Z), lens type (e.g. for fixed cameras only) and housing model number.
6. Detail and elevation drawings for all devices that define how they were installed and mounted.

- E. Pre-installation design packages shall be reviewed by the Contractor along with a VAMC representative to ensure all work has been clearly defined and completed. All reviews shall be conducted in accordance with the project schedule. There shall be one (1) stages to the review process:
 - 1. 100 percent
- F. Provide manufacturer security system product cut-sheets. Submit for approval at least 30 days prior to commencement of formal testing, a Security System Operational Test Plan. Include procedures for operational testing of each component and security subsystem, to include performance of an integrated system test.
- G. Submit manufacture's certification of Underwriters Laboratories, Inc. (UL) listing as specified. Provide all maintenance and operating manuals per the VAMC General Requirements, Section 01 00 00, GENERAL REQUIREMENTS.

1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below (including amendments, addenda, revisions, supplement, and errata) form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American National Standards Institute (ANSI)/Electronic Industries Alliance (EIA):
 - 330.....Electrical Performance Standards for CCTV
Cameras
 - 375A.....Electrical Performance Standards for CCTV
Monitors
- C. Institute of Electrical and Electronics Engineers (IEEE):
 - C62.41.....IEEE Recommended Practice on Surge Voltages in
Low-Voltage AC Power Circuits
 - 802.3af.....Power over Ethernet Standard
- D. National Electrical Contractors Association (NECA):
 - 303-2005.....Installing Closed Circuit Television (CCTV)
Systems
- E. National Fire Protection Association (NFPA):
 - 70-11.....Article 780-National Electrical Code

- F. Federal Information Processing Standard (FIPS):
 - 140-2.....Security Requirements for Cryptographic Modules
- G. Underwriters Laboratories, Inc. (UL):
 - 983-06.....Standard for Surveillance Camera Units
 - 3044-01.....Standard for Surveillance Closed Circuit
Television Equipment

1.6 WARRANTY OF CONSTRUCTION.

Warrant CCTV System work subject to the Article "Warranty of Construction" of FAR clause 52.246-21.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS

- A. All equipment associated within the CCTV System shall be UL 3004 compliant and rated for continuous operation.
- B. All equipment shall operate on a 120 or 208 volts alternating current (VAC); 60 Hz AC power system unless documented otherwise in subsequent sections listed within this specification. All equipment shall have a back-up source of power that will provide a minimum of 96 hours of run time in the event of a loss of primary power to the facility.
- C. The system shall be designed, installed, and programmed in a manner that will allow for easy of operation, programming, servicing, maintenance, testing, and upgrading of the system.
- D. All equipment and materials for the system will be compatible to ensure correct operation.

2.2 EQUIPMENT ITEMS

- A. CCTV system shall meet following requirements:
- B. All Cameras will be EIA 330 and UL 983 compliant as well as:
 - 1. Will be charge coupled device (CCD) cameras and shall conform to National Television System Committee (NTSC) formatting.
 - 2. Fixed cameras shall be color and the primary choice for monitoring following the activities described below. Pan/Tilt/Zoom (P/T/Z) cameras shall be color and are to be utilized to complement the fixed cameras.
 - 3. Shall be powered by either 12 volts direct current (VDC) or 24 VAC. Power supplies shall be Class 2 and UL compliant and have a back-up power source to ensure cameras are still operational in the event of loss of primary power to the CCTV System.

4. Shall be rated for continuous operation under the following environmental conditions:
 - a. Ambient temperatures of minus 10 degrees C (14 degrees F) to 55 degrees C (131 degrees F) utilizing equipment that will provide automatic heating and cooling.
 - b. Humidity, wind gusts, ice loading, and seismic conditions specified or encountered for locations where CCTV cameras will be utilized.
5. Will be home run to a monitoring and recording device via a controlling device such as a matrix switcher or network server and monitored on a 24 hour basis at a designated Access Control System and Database Management location.
6. Each function and activity shall be addressed within the system by a unique twenty (20) character user defined name. The use of codes or mnemonics identifying the CCTV action shall not be accepted.
7. Shall come with built-in video motion detection that shall automatically monitor and process information from each camera. The camera motion detection shall detect motion within the camera's field of view and provide automatic visual, remote alarms, and motion-artifacts as a result of detected motion as follows:
 - a. Motion-detection settings shall include adjustable object size and velocity, as well as a selectable detection area of 132 zones in a twelve (12) x eleven (11) grid.
 - b. Sensors shall accept video signals from CCTV cameras and when synchronizing is required, it shall be in composite synchronization.
 - c. Sensor processors shall detect motion by digitizing multiple pixels within each video scene and by comparing the gray scale of the pixels to a previously stored reference. The number of pixels digitized depends on the application. The designer of the system shall consider cost effectiveness as a factor since digitizing a large number of pixels could increase cost dramatically with little additional actual detection capability for a specific application.
 - d. An alarm shall be initiated when the comparison varies by six (6) percent or more.

8. Appropriate signage shall be designed, provided, and posted that notifies people that an area is under camera surveillance.
9. Dummy or fake cameras will not be utilized at any time.
10. Shall be programmed to digitally flip from color to black and white at dusk and vise versa at dawn.
11. Will be fitted with auto-iris lenses to ensure the image is maintained in low light.
12. Lightning protection shall be IEEE C62.41 compliant and provided for all cameras. Either surge protectors or a lightning grid may be utilized. Ensure all lightning protection equipment is compliant with Article 280 of the National Electrical Code (NEC). The use of Fuses and Circuit Breakers as a means of lightning protection shall not be allowed.
13. If using the camera as part of a CCTV network a video encoder shall be used to convert the signal from National Television System(s) Committee (NTSC) to Moving Picture Experts Group (MPEG) format.
14. P/T/Z cameras shall be utilized in a manner that they compliment fixed cameras and shall not be used as a primary means of monitoring activity.
15. Fixed Color Cameras Technical Characteristics:

Imaging Device	1/3-inch interline transfer CCD
Picture Elements	NTSC 510 (H) x 492 (V)
Scanning System	NTSC 525 lines, 21 interlace
Synchronization System	AC line lock/internal
Horizontal Resolution	330 TV lines
Iris Control	Selectable on/off
Electronic Shutter Range	NTSC 1/60-1/100,000 second
Auto Iris Lens Type	DC/video drive (auto sensing)
Minimum Illumination	0.6 lux
Signal to Noise Ratio	>50 dB
Automatic Gain Control	On/off switchable
Backlight Compensation	On/off switchable
Auto White Balance	On/off switchable
Video Output	1 Vp-p, 75 ohms
Power Consumption	Less than 5 watts
Video Connector	BNC
Lens Mount	C/CS mount (adjustable)

16. P/T/Z Cameras Technical Characteristics:

Effective Pixels	768 (H) x 494 (V)
Scanning Area	1/4-type CCD
Synchronization	Internal/Line-lock/Multiplexed Vertical Drive (VD2)
Video Output	1.0 v[p-p] NTSC composite/75 ohm
H. Resolution	570-line at B/W, or 480-line at color imaging
Signal-to-noise Ratio	50dB (AGC off, weight on)
Super Dynamic II	64 times (36dB) (selectable on/off)
Minimum Illumination	0.06 lx (0.006 fc) at B/W, 1 lx(0.1 fc)
Zoom Speed	Approx. 2.1s (TELE/WIDE) in sequence mode
Focus Speed	Approx. 2s (FAR/NEAR) in sequence mode
Iris	Automatic (Open/Close is possible)/manual
Maximum Aperture Ratio	1:1.6 (Wide) ~ 3.0 (Tele)
Focal Length	3.79 ~ 83.4 mm
Angular Field of View	H 2.6° ~ 51.7° V 2.0° ~ 39.9°
Electronic Shutter	1/60 (off), 1/100, 1/250, 1/500, 1/1,000, 1/2,000, 1/4,000, 1/10,000 s
Zoom Ratio	Optical 22x w/10x electronic zoom
Iris Range	F1.6 ~ 64, Close
Panning Range	360° endless
Panning Speed	Manual: Approx. 0.1°/s ~ 120°/s 16 steps
Tilting Range	0 ~ 90° (Digital Flip off), 0 ~180° (Digital Flip on)
Tilting Speed	Manual: Approx. 0.1°/s ~ 120°/s. 16 steps
Pan/Tilt	Manual/Sequential position/Auto Pan

Controls	Pan/Tilt, Lens, 64 Preset Positions, Home Position
Video Connector	BNC
Controller I/F	Multiplex-coaxial

C. Lenses: Shall be utilized in a manner that provides maximum coverage of the area being monitored by the camera. The lenses shall:

1. Be 1/3" to fit CCD fixed camera.
2. Be all glass with coated optics.
3. Have mounts that are compatible with the camera selected.
4. Be packaged and supplied with the camera.
5. Have a maximum f-stop of f/1.3 for fixed lenses, and a maximum f-stop of f/1.6 for variable focus lenses.
6. Be equipped with an auto-iris mechanism.
7. Have sufficient circle of illumination to cover the image sensor evenly.
8. Not be used on a camera with an image format larger than the lens is designed to cover.
9. Be provided with pre-set capability.

D. Two types of lenses shall be utilized for interior fixed cameras:

1. Manual Variable Focus
2. Auto Iris Fixed

E. Manual Variable Focus:

1. Shall be utilized in large areas that are being monitored by the camera. Examples of this are perimeter fence lines, vehicle entry points, parking areas, etc.
2. Shall allow for setting virtually any angle of field, which maximizes surveillance effects.

3. Technical Characteristics:

Image format	1/3 inch
Focal length	5-50mm
Iris range	F1.4 to close
Focus range	1m (3.3 ft)
Back focus distance	10.05 mm (0.4 in)
Angle view Wide (1/3 in)	53.4 x 40.1
Angle view Tele (1/3 in)	5.3 x 4.1
Iris control	manual

Focus ctrl	manual
Zoom ctrl	manual

F. Auto Iris Fixed

1. Shall be utilized in areas where a small specific point of reference is to be monitored. Examples of this are doorways, elevators, cashier booths, etc.
2. To determine the exact size of the fixed lens required, complete a focal length calculation using either a focal length calculator or a focal length chart provided by the product manufacturer.
3. Technical Characteristics:

Image format	1/3 inch	1/3 inch	1/3 inch
Focal length	2.8 mm	4 mm	8 mm
Iris range	F1.2 - 200	F1.2 - 200	F1.2 - 200
Min. Object	0.3 m (1 ft)	0.3 m (1 ft)	0.3 m (1 ft)
Lens mount	CS-mount	CS-mount	CS-mount
Angle of view	94 X 72	64 X 49	33 x 25
Focus control	Manual	Manual	manual

G. Video Display Equipment

1. Existing.

H. Camera Housings and Mounts:

1. This section pertains to all interior housings, domes, and applicable wall, ceiling, corner mounts associated with the housing. Housings and mounts shall be specified in accordance to the type of cameras used.
2. All cameras and lenses shall be enclosed in a tamper resistant housing. Any additional mounting hardware required to install the camera housing at its specified location shall be provided along with the housing.
3. The camera and lens contained inside the housing shall be installed on a camera mount. All additional mounting hardware required to install the camera housing at its specified location shall be provided along with the housing.

4. Shall be manufactured in a manner that are capable of supporting a maximum of three (3) cameras with housings, and meet environmental requirements for the geographical area the camera support equipment is being installed on or within.
5. Environmentally Sealed
 - a. Shall:
 - 1) Be designed in manner that it provides a condensation free environment for correct camera operation.
 - 2) Operate in a 100 percent condensing humidity atmosphere.
 - 3) Be constructed in a manner that:
 - a) Has a fill valve to allow for the introduction of nitrogen into the housing to eliminate existing atmospheric air and pressurize the housing to create moisture free conditions.
 - b) Has an overpressure valve to prevent damage to the housing in the event of over pressurization.
 - c) Is equipped with a humidity indicator that is visible to the eye to ensure correct atmospheric conditions at all times.
 - d) The leak rate of the housing is not to be greater than 13.8kPa or 2 pounds per square inch at sea level within a 90 day period.
 - e) It shall contain camera mounts or supports as needed to allow for correct positioning of the camera and lens.
 - f) The housing and sunshield are to be white in color.
 - b. All electrical and signal cables required for correct operations shall be supplied in a hardened carrier system from the controller to the camera.
 - c. The mounting bracket shall be adjustable to allow for the housing weight of the camera and the housing unit it is placed in.
 - d. Accessibility to the camera and mounts shall be taken into consideration for maintenance and service purposes.
6. Indoor Mounts
 - a. Ceiling Mounts:
 - 1) This enclosure and mount shall be installed in a finished or suspended ceiling.
 - 2) The enclosure and mount shall be fastened to the finished ceiling, and shall not depend on the ceiling tile grid for complete support.

- 3) Suspended ceiling mounts shall be low profile, and shall be suitable for replacement of 2 foot by 2 foot (610mm x 610mm) ceiling tiles.

b. Wall Mounts:

- 1) The enclosure shall be installed in manner that it matches the existing décor and placed at a height that it will be unobtrusive, unable to cause personal harm, and prevents tampering and vandalism.
- 2) The mount shall contain a manual pan/tilt head that will provide 360 degrees of horizontal and vertical positioning from a horizontal position, and has a locking bar or screw to maintain its fixed position once it has been adjusted.

7. Interior Domes

- a. The interior dome shall be a pendant mount, pole mount, ceiling mount, surface mount, or corner mounted equipment.
- b. The lower portion of the dome that provides camera viewing shall be made of black opaque acrylic and shall have a light attenuation factor of no more than 1 f-stop.
- c. The housing shall be equipped with integral pan/tilt capabilities complete with wiring, wiring harness, connectors, receiver/driver, pan/tilt control system, pre-position cards, or any other hardware and equipment as needed to fully provide a fully functional pan/tilt dome.
- d. The pan/tilt mechanism shall be:
 - 1) Constructed of heavy duty bearings and hardened steel gears.
 - 2) Permanently lubricated to ensure smooth and consistent movement of all parts throughout the life of the product.
 - 3) Equipped with motors that are thermally or impedance protected against overload damage.
- e. Pan movements shall be 360 degrees and tilt movement shall not be less than +/- 90 degrees.
- f. Pan speed shall be a minimum of 10 degrees per second.

I. Controlling Equipment

1. Existing.
2. Matrix Switcher: The matrix switcher shall meet the following minimum requirements:
 - a. Take multiple camera inputs and route them to multiple monitoring stations.

- b. Allow for centralized user management controlling configurations.
- c. Provide live viewing of all cameras.
- d. Provide P/T/Z, focus, and iris control of all unitized cameras.
- e. Be expandable to allow for the addition of multiple cameras and monitoring stations over the life of the system visual identification system by utilizing input and output video and controller cards.
- f. Input cards shall allow for the addition of a minimum of four (4) camera inputs per card.
- g. Output cards shall allow for the addition of a minimum of eight (8) outputs per card.
- h. Have the ability to be programmed either locally or remotely.
- i. Remotely operate multiple cameras from multiple stations.
- j. Be able to fully interface with a digital video recorder (DVR) for recording of all events.
- k. Utilize RS-232 or fiber optic connections for integration with the SMS computer station via a remote port on a network hub.
- l. Shall have an alarm interface that is compatible with all associated security subsystems. Alarm inputs shall be via either a relay or an EIA ANSI/EIA/TIA-232-F interface. The interface shall allow for a minimum of 24 alarm inputs and 12 alarm outputs.
- m. The switcher response time to an alarm input shall not be less than 200 milliseconds from the time an alarm is sensed until a picture is displayed on a monitor.
- n. The switcher shall have a built in buffer to allow for back-log of alarms. These alarms shall be viewable by an operator.
- o. Be addressable in the event multiple matrix switchers are connected to the SMS.
- p. Be configured, i.e. camera names, monitor names, sequences, alarms and alarm actions, etc. utilizing the configuration program and tools provided by the matrix manufacturer.
- q. The matrix switcher shall meet the following minimum input/output requirements:

Camera inputs	16
Video outputs	4
Keyboard/Controller Outputs	4
Alarm inputs	323

r. The matrix switcher will have the following components and technical characteristics:

1) Main Unit:

Functions	Monitor control Camera selection, tour sequence, group sequence, group preset, OSD display, Camera/Receiver control via coaxial or RS-485 cable communication, Recorder control
Alarm control	Alarm event, Alarm Acknowledge, Alarm reset, Alarm suspension, Alarm History Display, Timer event, and Camera event
RS-485 (Camera) Port	6-conductor modular jack x 12 (2-wire or 4-wire communication, With termination switches (MODE 1 to 4))
Extension Port	6-conductor modular jack x 2 (With a (EXTENSION 1 IN, OUT) termination switch (TERM: ON, OFF))
Extension Port	37-pin D-sub connector x 2 (EXTENSION IN 2 or 3)
Extension Port	37-pin D-sub connector x 2 (EXTENSION OUT 2 or 3)

2) Input Board:

Camera Input	1 V [P-P]/75 Ohm (BNC), composite video signal 0.5 V [P-P]/75 Ohm data signal and 2.5 V [P-P]/75 Ohm (25 pin D sub connector x 4)
Alarm Input	N.O. (Normally Open contact) or N.C. (Normally Close contact) selectable x 32 (37 pin D sub connector)

3) Output Board:

Monitor Output	1 V [P-P]/75 Ohm (BNC)
Alarm Output	Open collector output x 32, Max. 24 VDC, 100 mA
Extension Port	6-conductor modular jack x 2
Serial Port	9-pin D-sub connector x 2

6. Network Server

- a. Allow for the transmission of live video, data, and audio over either an existing Ethernet network or a dedicated security system network, requiring an IP address or Internet Explorer 5.5 or higher, or shall work as an analog-to-Ethernet "bridge" controlling matrices, multiplexers, and pan/tilt/zoom cameras. The network shall operate in a box-to-box configuration allowing for encoded video to be decoded and displayed on an analog monitor.
- b. The following equipment shall be required as part of the extension and expansion of the existing system:
 - 1) Recording Device
 - 2) Matrix Switcher
- c. Shall provide overall control, programming, monitoring, and recording of all new cameras and associated devices within the CCTV System.
- d. All equipment on the network shall be IP addressable.
- e. The CCTV System network shall meet or exceed the following design and performance specifications:
 - 1) Two MPEG-4 video streams for a total of 40 images per second will be provided.
 - 2) PC Software that manages the installation and maintenance of all hardware transmitters and receivers on the network shall be provided.
 - 3) Video Source that supports any NTSC video source to the computer network shall be addressed.
 - 4) Receivers that could be used to display the video on a standard analog NTSC or PAL monitor will be addressed.

- f. The system shall support the following network protocols:
 - 1) Internet connections: RTP, Real Time Control Protocol (RTCP), UDP, IP, TCP, ICMP, HTTP, Simple Network Management Protocol (SNMP), IGMP, DHCP, and ARP.
 - 2) Video Display: MPEG-4, M-JPEG in server push mode only.
 - 3) Have the ability to adjust bandwidth, image quality and image rate.
 - 4) Support image sizes of either 704 x 576 pixels or 352 x 288 pixels.
 - 5) Have an audio coding format of G.711 or G.728.
 - 6) Provide a video frame rate of at least 30 images per second.
 - 7) Support LAN Interface Ethernet 10/100BaseT and be auto sensing.
 - 8) Have a LAN Data Rate of 9.6 Kbps to 5.0 Mbps.
 - 9) Utilize data interface RS-232/RS-422/RS-485.
- g. All connections within the system shall be via CAT-V cable and RJ-45 jacks. If analog equipment is used as part of the system, then either an encoder or a decoder will be utilized to convert the analog signal to a digital one.
- h. The CCTV network system shall conform to all VAMC agency wide security standards for administrator and operator use.

J. Recording Devices

- 1. All new cameras on the CCTV System shall be recorded in real time using a local Digital Video Recorder (DVR). The type of recording device utilized should be determined by the size and type of CCTV System designed and installed, and to what extent the system is to be utilized.
- 2. All recording devices shall be 19" (47.5 cm) rack-mountable.
- 3. All DVR's that are viewable over an Intranet or Internet will be routed through an encryptor. Encryptors shall:
 - a. Comply with FIPS PUB 140-2.
 - b. Support TCP/IP.
 - c. Directly interfaces to low-cost commercial routers.
 - d. Provide packet-based crypto synchronization.
 - e. Encrypt source and destination IP addresses.
 - f. Support web browser based management requiring no additional software.

- g. Have a high data sustained throughput – 1.544 Mbps (T1) full duplex data rate.
 - h. Provide for both bridging and routing network architecture support.
 - i. Support Electronic Key Management System (EKMS) compatible.
 - j. Have remote management ability.
 - k. Automatically reconfigure when secure network or wide area network changes.
4. Digital Video Recorder (DVR):
- a. Shall record video to a hard drive-based digital storage medium in either NTSC or MPEG format.
 - b. Shall meet the following minimum requirements:
 - 1) Record at minimum rate of 30 images per second (IPS).
 - 2) Have a minimum of eight (8) to 16 looping inputs.
 - 3) Have a minimum of eight (8) to 16 alarm inputs and two (2) relay outputs.
 - 4) Shall provide instantaneous playback of all recorded images.
 - 5) Be IP addressable, if part of a CCTV network.
 - 6) Have built-in digital motion detection with masking and sensitivity adjustments.
 - 7) Provide easy playback and forward/reverse search capabilities.
 - 8) Complete audit trail database, with minimum of a six-month history that tracks all events related to the alarm; specifically who, what, where and when.
 - 9) DVR management capability providing automatic video routing to a back-up spare recorder in case of failure.
 - 10) Accessible locally and remotely via the Internet, Intranet, or a personal digital assistant (PDA).
 - 11) Records all alarm events in real time, ensuring 60 seconds before and after the event are included in the recording.
 - 12) Utilize RS-232 or fiber optic connections for integration with the SMS computer station via a remote port on a network hub.
 - 13) Allow for independently adjustable frame rate settings.
 - 14) Be compatible with the matrix switcher utilized to operate the cameras.

c. Technical Characteristics:

Processor	Intel Pentium III 750 MHz
Memory	256 MB RAM
Operating System	Windows 98, NT, ME, 2000, and XP
Video Card	4 MB of RAM capable of 24-bit true color display
Free Hard Disk Space	160 MB for software installation
Network Card	10Base-T network for LAN operation
Archiving	80 GB, 160 GB, 320 GB and 640 GB Hard Drive; CD-RW
Video Input	1.0 Vpp (signal 714mV, sync 286mV) 75 ohms (BNC unbalanced)
Video Output Level	1.0 Vpp +/-10%, 75 ohms (BNC unbalanced)
Impedance	75 ohms/Hi- impedance x 16 switchable
Network Interface	Ethernet (RJ-45, 10/100M)
Network Protocol	TCP/IP, DHCP, HTTP, UDP
Network Capabilities	Live/Playback/P/T/Z control
Recording Rate	30 ips for 720 x 240 (NTSC)
Password Protection	Menu Setup, Remote Access
Recording Capacity	160 (1 or 2 fixed HDD) 1 CD-RW
Power Interrupt	Auto recovered to recording mode

K. Wires and Cables

1. Shall meet or exceed the manufactures recommendation for power and signal.

2. Will be carried in an enclosed conduit system, utilizing electromagnetic tubing (EMT) to include the equivalent in flexible metal, rigid galvanized steel (RGS) to include the equivalent of liquid tight, polyvinylchloride (PVC) schedule 40 or 80.
3. All conduits will be sized and installed per the NEC. All security system signal and power cables that traverse or originate in a high security office space will be contained in either EMT or RGS conduit.
4. All conduit, pull boxes, and junction boxes shall be clearly marked with colored permanent tape or paint that will allow it to be distinguished from all other conduit and infrastructure.
5. Conduit fills shall not exceed 50 percent unless otherwise documented.
6. A pull string shall be pulled along and provided with signal and power cables to assist in future installations.
7. At all locations where there is a wall penetration or core drilling is conducted to allow for conduit to be installed, fire stopping materials shall be applied to that area.
8. High voltage and signal cables shall not share the same conduit and shall be kept separate up to the point of connection. High voltage for the security system shall be defined as any cable or sets of cables carrying 30 VDC/VAC or higher.
9. For all equipment that is carrying digital data between the Access Control System and Database Management or at a remote monitoring station, shall not be less than 20 AWG and stranded copper wire for each conductor. The cable or each individual conductor within the cable shall have a shield that provides 100% coverage. Cables with a single overall shield shall have a tinned copper shield drain wire.
10. All cables and conductors, except fiber optic cables, that act as a control, communication, or signal lines shall include surge protection. Surge protection shall be furnished at the equipment end and additional triple electrode gas surge protectors rated for the application on each wire line circuit shall be installed within three (3) ft. (one (1) m.) of the building cable entrance. The inputs and outputs shall be tested in both normal and common mode using the following wave forms:
 - a. A 10 microsecond rise time by 1000 microsecond pulse width waveform with a peak voltage of 1500 volts and peak current of 60 amperes.

- b. An 8 microsecond rise time by 20 microsecond pulse width wave form with a peak voltage of 1000 volts and peak current of 500 amperes.
- 11. The surge suppression device shall not attenuate or reduce the video or sync signal under normal conditions. Fuses and relays shall not be used as a means of surge protection.
- 12. Coaxial Cables
 - a. All video signal cables for the CCTV System shall be a coaxial cable and have a characteristic impedance of 75 ohms plus or minus 3 ohms.
 - b. For runs up to 750 feet use of an RG-59/U is required. The RG-59/U shall be shielded which provides a minimum of 95 percent coverage, with a stranded copper center conductor of a minimum 23 AWG, polyethylene insulation, and black non-conductive polyvinylchloride (PVC) jacket.
 - c. For runs between 750 feet and 1250 feet, RG-6/U is required. RG-6/U shall be shielded which provides a minimum of 95 percent coverage, with a stranded copper center conductor of a minimum 18 AWG, polyethylene insulation, and black non-conductive polyvinylchloride (PVC) jacket.
 - d. For runs of 1250 to 2750 feet, RG-11/U is required. RG-11/U shall be shielded which provides a minimum of 95 percent coverage, with a stranded copper center conductor of a minimum 14 AWG, polyethylene insulation, and black non-conductive polyvinylchloride (PVC) jacket.
 - e. All runs greater than 2750 feet will be substituted with a fiber optic cable. If using fiber optics as a signal carrier then the following equipment will be utilized:
 - 1) Multimode fiber optic cable a minimum size of 62 microns
 - 2) Video transmitter, installed at the camera that utilizes 12 VDC or 24 VAC for power.
 - 3) Video receiver, installed at the switcher.

f. RG-59/U Technical Characteristics

AWG	22
Stranding	7x29
Conductor Diameter	.031 in.
Conductor Material	BCC
Insulation Material	Gas-injected FHDPE
Insulation Diameter	.145 in.
Outer Shield Type	Braid/Braid
Outer Jacket Material	PVC
Overall Nominal Diameter	.242 in.
UL Temperature Rating	75°C
Nom. Characteristic Impedance	75 Ohms
Nom. Inductance	0.094 μ H/ft
Nom. Capacitance	Conductor to Shield 17.0 pF/ft
Nom. Velocity of Propagation	80 %
Nom. Delay	1.3 ns/ft
Nom. Conductor DC Resistance @ 20°C	12.2 Ohms/1000 ft
Nom. Outer Shield DC Resistance @ 20°C	2.4 Ohms/1000 ft
Max. Operating Voltage	UL 300 V RMS

g. RG-6/U Technical Characteristics:

AWG	18
Stranding	7x27
Conductor Diameter	.040 in.
Conductor Material	BC
Insulation Material	Gas-injected FHDPE
Insulation Diameter	.180 in.
Outer Shield Material	Trade Name Duofoil

Outer Shield Type	Tape/Braid
Outer Shield %Coverage	100 %
Outer Jacket Material	PVC
Overall Nominal Diameter	.274 in.
Nom. Characteristic Impedance	75 Ohms
Nom. Inductance	0.106 μ H/ft
Nom. Capacitance	Conductor to Shield 16.2 pF/ft
Nom. Velocity of Propagation	82 %
Nom. Delay	1.24 ns/ft
Nom. Conductor DC Resistance	6.4 Ohms/1000 ft
Nominal Outer Shield DC Resistance @ 20°C	2.8 Ohms/1000 ft
Max. Operating Voltage	UL 300 V RMS

h. RG-11/U Technical Characteristics:

AWG	15
Stranding	19x27
Conductor Diameter	.064 in.
Conductor Material	BC
Insulation Material	Gas-injected FHDPE
Insulation Diameter	.312 in.
Inner Shield Type	Braid
Inner Shield Material	BC - Bare Copper
Inner Shield %Coverage	95 %
Inner Jacket Material	PE - Polyethylene
Inner Jacket Diameter	.391 in.
Outer Shield Type	Braid
Outer Shield Material	BC - Bare Copper
Outer Shield %Coverage	95 %
Outer Jacket Material	Trade Name Belflex

Outer Jacket Material	PVC Blend
Overall Nominal Diameter	.520 in.
Operating Temperature Range	-35°C To +75°C
Non-UL Temperature Rating	75°C
Nom. Characteristic Impedance	75 Ohms
Nom. Inductance	0.097 μ H/ft
Nom. Capacitance	Conductor to Shield 17.3 pF/ft
Nom. Velocity of Propagation	78 %
Nom. Delay	1.30 ns/ft
Nom. Conductor DC Resistance	3.1 Ohms/1000 ft
Nom. Inner Shield DC Resistance	1.8 Ohms/1000 ft
Nom. Outer Shield DC Resistance	1.4 Ohms/1000 ft
Max. Operating Voltage Non-UL	300 V RMS

13. Power Cables

- a. Will be sized accordingly and shall comply with the NEC. High voltage power cables will be a minimum of three conductors, 14 AWG, stranded, and coated with a non-conductive polyvinylchloride (PVC) jacket. Low voltage cables will be a minimum of 18 AWG, stranded and non-conductive polyvinylchloride (PVC) jacket.
- b. Will be utilized for all components of the CCTV System that require either a 110 VAC 60 Hz or 220 VAC 50 Hz input. Each feed will be connected to a dedicated circuit breaker at a power panel that is primarily for the security system.
- c. All equipment connected to AC power shall be protected from surges. Equipment protection shall withstand surge test waveforms described in IEEE C62.41. Fuses shall not be used as a means of surge protection.

- d. Shall be rated for either 110 or 208 VAC, 60 Hz, and shall comply with VAMC Master Spec 26 05 21 Low Voltage Electrical Power Conductors and Cables (600 Volts and Below).
- e. Low Voltage Power Cables
 - 1) Shall be a minimum of 18 AWG, Stranded and have a polyvinylchloride outer jacket.
 - 2) Cable size shall determined using a basic voltage over distance calculation and shall comply with the NEC's requirements for low voltage cables.

2.3 INSTALLATION KIT

A. General:

1. The kit shall be provided that, at a minimum, includes all connectors and terminals, labeling systems, audio spade lugs, barrier strips, punch blocks or wire wrap terminals, heat shrink tubing, cable ties, solder, hangers, clamps, bolts, conduit, cable duct, and/or cable tray, etc., required to accomplish a neat and secure installation. All wires shall terminate in a spade lug and barrier strip, wire wrap terminal or punch block. Unfinished or unlabeled wire connections shall not be allowed. All unused and partially opened installation kit boxes, coaxial, fiber-optic, and twisted pair cable reels, conduit, cable tray, and/or cable duct bundles, wire rolls, physical installation hardware shall be turned over to the Contracting Officer's Technical Representative (COR). The following sections outline the minimum required installation sub-kits to be used:
2. System Grounding:
 - a. The grounding kit shall include all cable and installation hardware required. All head end equipment and power supplies shall be connected to earth ground via internal building wiring, according to the NEC.
 - b. This includes:
 - 1) Coaxial Cable Shields
 - 2) Control Cable Shields
 - 3) Data Cable Shields
 - 4) Equipment Racks
 - 5) Equipment Cabinets
 - 6) Conduits
 - 7) Cable Duct blocks

- 8) Cable Trays
 - 9) Power Panels
 - 10) Grounding
 - 11) Connector Panels
- 3. Coaxial Cable: The coaxial cable kit shall include all coaxial connectors, cable tying straps, heat shrink tabbing, hangers, clamps, etc., required to accomplish a neat and secure installation.
 - 4. Wire and Cable: The wire and cable kit shall include all connectors and terminals, audio spade lugs, barrier straps, punch blocks, wire wrap strips, heat shrink tubing, tie wraps, solder, hangers, clamps, labels etc., required to accomplish a neat and orderly installation.
 - 5. Conduit, Cable Duct, and Cable Tray: The kit shall include all conduit, duct, trays, junction boxes, back boxes, cover plates, feed through nipples, hangers, clamps, other hardware required to accomplish a neat and secure conduit, cable duct, and/or cable tray installation in accordance with the NEC and this document.
 - 6. Equipment Interface: The equipment kit shall include any item or quantity of equipment, cable, mounting hardware and materials needed to interface the systems with the identified sub-system(s) according to the OEM requirements and this document.
 - 7. Labels: The labeling kit shall include any item or quantity of labels, tools, stencils, and materials needed to correctly label each subsystem according to the OEM requirements, as-installed drawings, and this document.
 - 8. Documentation: The documentation kit shall include any item or quantity of items, computer discs, as installed drawings, equipment, maintenance, and operation manuals, and OEM materials needed to correctly provide the system documentation as required by this document and explained herein.

PART 3

3.1 INSTALLATION

- A. System installation shall be in accordance with NECA 303, manufacturer and related documents and references, for each type of security subsystem designed, engineered and installed.
- B. Components shall be configured with appropriate "service points" to pinpoint system trouble in less than 30 minutes.

- C. The Contractor shall install all system components including Government furnished equipment, and appurtenances in accordance with the manufacturer's instructions, documentation listed in Sections 1.4 and 1.5 of this document, and shall furnish all necessary connectors, terminators, interconnections, services, and adjustments required for a complete and operable system.
- D. The CCTV System will be designed, engineered, installed, and tested to ensure all components are fully compatible as a system. H. A complete extension of the existing CCTV System shall be comprised of, but not limited to, the following components:
1. Cameras
 2. Lenses
 3. Camera Housings and Mounts
 4. Matrix Switching Equipment
 5. Recording Devices
 6. Wiring and Cables
- E. The Contractor shall visit the site and verify that site conditions are in agreement/compliance with the design package. The Contractor shall report all changes to the site or conditions that will affect performance of the system to the Contracting Officer's Technical Representative (COR) in the form of a report. The Contractor shall not take any corrective action without written permission received from the Contracting Officer's Technical Representative (COR).
- F. Existing Equipment
1. The Contractor shall connect to and utilize existing video equipment, video and control signal transmission lines, and devices as outlined in the design package. Video equipment and signal lines that are usable in their original configuration without modification may be reused with Contracting Officer's Technical Representative's (COR) approval.
 2. The Contractor shall perform a field survey, including testing and inspection of all existing video equipment and signal lines intended to be incorporated into the CCTV System, and furnish a report to the Contracting Officer as part of the site survey report. For those items considered nonfunctioning, provide (with the report)

- specification sheets, or written functional requirements to support the findings and the estimated cost to correct the deficiency. As part of the report, the Contractor shall include a schedule for connection to all existing equipment.
3. The Contractor shall make written requests and obtain approval prior to disconnecting any signal lines and equipment, and creating equipment downtime. Such work shall proceed only after receiving Contracting Officer's Technical Representative's (COR) approval of these requests. If any device fails after the Contractor has commenced work on that device, signal or control line, the Contractor shall diagnose the failure and perform any necessary corrections to the equipment.
 4. The Contractor shall be held responsible for repair costs due to Contractor negligence, abuse, or incorrect installation of equipment.
 5. The Contracting Officer's Technical Representative (COR) shall be provided a full list of all equipment that is to be removed or replaced by the Contractor, to include description and serial/manufacturer numbers where possible. The Contractor shall dispose of all equipment that has been removed or replaced based upon approval of the Contracting Officer's Technical Representative (COR) after reviewing the equipment removal list. In all areas where equipment is removed or replaced the Contractor shall repair those areas to match the current existing conditions.
- G. Enclosure Penetrations: All enclosure penetrations shall be from the bottom of the enclosure unless the system design requires penetrations from other directions. Penetrations of interior enclosures involving transitions of conduit from interior to exterior, and all penetrations on exterior enclosures shall be sealed with rubber silicone sealant to preclude the entry of water and will comply with VAMC Master Specification 07 84 00, Firestopping. The conduit riser shall terminate in a hot-dipped galvanized metal cable terminator. The terminator shall be filled with an approved sealant as recommended by the cable manufacturer and in such a manner that the cable is not damaged.
- H. Cold Galvanizing: All field welds and brazing on factory galvanized boxes, enclosures, and conduits shall be coated with a cold galvanized paint containing at least 95 percent zinc by weight.

I. Interconnection of Console Video Equipment: The Contractor shall connect signal paths between video equipment as specified by the OEM. Cables shall be as short as practicable for each signal path without causing strain at the connectors. Rack mounted equipment on slide mounts shall have cables of sufficient length to allow full extension of the slide rails from the rack.

J. Cameras:

1. Install the cameras with as indicated for each zone.
2. Connect power and signal lines to the camera.
3. Set cameras with fixed iris lenses to the f-stop to give full video level.
4. Aim camera to give field of view as needed to cover the alarm zone.
5. Focus the lens to give a sharp picture (to include checking for day and night focus and image quality) over the entire field of view; and synchronize all cameras so the picture does not roll on the monitor when cameras are selected. Dome cameras shall have all preset positions defined and installed.

K. Switcher:

1. Install the switcher as shown in the design and construction documents, and according to the OEM.
2. Connect all subassemblies as specified by the manufacturer and as shown.
3. Connect video signal inputs and outputs as shown and specified; terminate video inputs as required.
4. Connect alarm signal inputs and outputs as shown and specified; connect control signal inputs and outputs for ancillary equipment or secondary control/monitoring sites as specified by the manufacturer and as shown.
5. Connect the switcher CPU and switcher subassemblies to AC power.
6. Load all software as specified and required for an operational CCTV System configured for the site and building requirements, including data bases, operational parameters, and system, command, and application programs.
7. Provide the original and 2 backup copies for all accepted software upon successful completion of the endurance test.
8. Program the video annotation for each camera.

L. Video Recording Equipment:

1. Install the video recording equipment as shown in the design and construction documents, and as specified by the OEM.
2. Connect video signal inputs and outputs as shown and specified.
3. Connect alarm signal inputs and outputs as shown and specified.
4. Connect video recording equipment to AC power.

M. Video Signal Equipment:

1. Install the video signal equipment as shown in the design and construction documents, and as specified by the OEM.
2. Connect video or signal inputs and outputs as shown and specified.
3. Terminate video inputs as required.
4. Connect alarm signal inputs and outputs as required.
5. Connect control signal inputs and outputs as required
6. Connect electrically powered equipment to AC power.

N. Camera Housings and Mounts:

1. Install the camera housings and mounts as specified by the manufacturer.
2. Connect signal lines and AC power to the housing interfaces.

O. System Start-Up

1. The Contractor shall not apply power to the CCTV System until the following items have been completed:
 - a. CCTV System equipment items and have been set up in accordance with manufacturer's instructions.
 - b. A visual inspection of the CCTV System has been conducted to ensure that defective equipment items have not been installed and that there are no loose connections.
 - c. System wiring has been tested and verified as correctly connected as indicated.
 - d. All system grounding and transient protection systems have been verified as installed and connected as indicated.
 - e. Power supplies to be connected to the CCTV System have been verified as the correct voltage, phasing, and frequency as indicated.
2. Satisfaction of the above requirements shall not relieve the Contractor of responsibility for incorrect installation, defective equipment items, or collateral damage as a result of Contractor work efforts.

P. Supplemental Contractor Quality Control

1. The Contractor shall provide the services of technical representatives who are familiar with all components and installation procedures of the installed CCTV System; and are approved by the Contracting Officer's Technical Representative (COR).
2. The Contractor will be present on the job site during the preparatory and initial phases of quality control to provide technical assistance.
3. The Contractor shall also be available on an as needed basis to provide assistance with follow-up phases of quality control.
4. The Contractor shall participate in the testing and validation of the system and shall provide certification that the system installed is fully operational as all construction document requirements have been fulfilled.

3.2 TESTING AND TRAINING

All testing and training shall be compliant with the VAMC General Requirements, Section 01 00 00, GENERAL REQUIREMENTS.

-----END-----

SECTION 28 31 00
FIRE DETECTION AND ALARM

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section of the specifications includes the furnishing, installation, and connection to the existing Fire Alarm System to form a complete coordinated system ready for operation. It shall include: alarm initiating devices, alarm notification appliances, control units, fire safety control devices, power supplies, and wiring as shown on the drawings and specified.
- B. Fire alarm system shall comply with requirements of NFPA 72 unless variations to NFPA 72 are specifically identified within these contract documents by the following notation: "variation". The design, system layout, document submittal preparation, and supervision of installation and testing shall be provided by a technician that is certified NICET level III or a registered fire protection engineer. The NICET certified technician shall be on site for the supervision and testing of the system. Factory engineers from the equipment manufacturer, thoroughly familiar and knowledgeable with all equipment utilized, shall provide additional technical support at the site as required by the Contracting Officer's Technical Representative (COR) or his authorized representative. Installers shall have a minimum of two years' experience installing fire alarm systems.
- C. Fire alarm signals:
 - 1. Automatic chime signal to notify occupants to evacuate.
- D. Alarm signals (by device), supervisory signals (by device) and system trouble signals (by device not reporting) shall be distinctly transmitted to the main fire alarm system control unit.

1.2 SCOPE

- A. All existing fire alarm equipment, wiring, devices and sub-systems that are not shown to be reused shall be removed. All existing fire alarm conduit not reused shall be removed.
- B. An extension to the existing fire alarm system shall be designed and installed in accordance with the specifications and drawings. Device location and wiring runs shown on the drawings are for reference only unless specifically dimensioned. Actual locations shall be in accordance with NFPA 72 and this specification.

- C. Existing fire alarm bells, chimes, door holders, duct smoke detectors, valve tamper switches and waterflow/pressure switches may be reused only as specifically indicated on the drawings and provided the equipment:
 - 1. Meets this specification section
 - 2. Is UL listed or FM approved
 - 3. Is compatible with new equipment being installed
 - 4. Is verified as operable through contractor testing and inspection
 - 5. Is warranted as new by the contractor.
- D. Existing reused equipment shall be covered as new equipment under the Warranty specified herein.
- E. Basic Performance:
 - 1. Response time between alarm initiation (contact closure) and recording at the main fire alarm control unit (appearance on alphanumeric read out) shall not exceed five (5) seconds.
 - 2. Initiating device circuits (IDC) shall be wired Style C in accordance with NFPA 72.
 - 3. Signaling line circuits (SLC) within buildings shall be wired Style 4 in accordance with NFPA 72. Individual signaling line circuits shall be limited to covering 22,500 square feet of floor space.
 - 4. Notification appliance circuits (NAC) shall be wired Style Y in accordance with NFPA 72.

1.3 RELATED WORK

- A. 10 00 00 - General Requirements.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES: Procedures for submittals.
- C. Section 07 84 00, FIRESTOPPING: Fire proofing wall penetrations.
- D. Section 08 71 00, DOOR HARDWARE:
- E: Section 21 13 13, WET-PIPE SPRINKLER SYSTEMS: Sprinkler systems.
- F. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements for items which are common to other Division 26 sections.
- G. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits and boxes for cables/wiring.
- H. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW: Cables/wiring.

1.4 SUBMITTALS

- A. General: Submit 4 copies and 1 reproducible in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, and Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

B. Drawings:

1. Prepare drawings using AutoCAD Release 2009 software and include all Contractors' information. Layering shall be by VA criteria as provided by the Contracting Officer's Technical Representative (COR). Bid drawing files on AutoCAD 2009 will be provided to the Contractor at the pre-construction meeting. The contractor shall be responsible for verifying all critical dimensions shown on the drawings provided by VA.
2. Floor plans: Provide locations of all devices (with device number at each addressable device corresponding to control unit programming), appliances, panels, equipment, junction/terminal cabinets/boxes, risers, electrical power connections, individual circuits and raceway routing, system zoning; number, size, and type of raceways and conductors in each raceway; conduit fill calculations with cross section area percent fill for each type and size of conductor and raceway. Only those devices connected and incorporated into the final system shall be on these floor plans. Do not show any removed devices on the floor plans. Show all interfaces for all fire safety functions.
3. Riser diagrams: Provide, for the new work, the number, size and type of riser raceways and conductors in each riser raceway and number of each type device per floor and zone. Show door holder interface, HVAC shutdown interface, fire extinguishing system interface, and all other fire safety interfaces. Show wiring styles on the riser diagram for all circuits.
4. Detailed wiring diagrams: Provide for control panels, modules, power supplies, electrical power connections, auxiliary relays and annunciators showing termination identifications, size and type conductors, circuit boards, LED lamps, indicators, adjustable controls, switches, ribbon connectors, wiring harnesses, terminal strips and connectors, spare zones/circuits. Diagrams shall be drawn to a scale sufficient to show spatial relationships between components, enclosures and equipment configuration.
5. Two weeks prior to final inspection, the Contractor shall deliver to the COR one (1) set of reproducible, as-built drawings, two blue-line copies and one (1) set of the as-built drawing computer files using AutoCAD Release 2009 or later. As-built drawings (floor plans) shall show all new and existing conduit used for the fire alarm system.

C. Manuals:

1. Submit simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals including technical data sheets for all items used in the system, power requirements, device wiring diagrams, dimensions, and information for ordering replacement parts.
 - a. Wiring diagrams shall have their terminals identified to facilitate installation, operation, expansion and maintenance.
 - b. Wiring diagrams shall indicate internal wiring for each item of equipment and the interconnections between the items of equipment.
 - c. Include complete listing of all software used and installation and operation instructions including the input/output matrix chart.
 - d. Provide a clear and concise description of operation that gives, in detail, the information required to properly operate, inspect, test and maintain the equipment and system. Provide all manufacturer's installation limitations including but not limited to circuit length limitations.
 - e. Complete listing of all updated digitized voice messages.
 - f. Provide standby battery calculations under normal operating and alarm modes. Battery calculations shall include the magnets for holding the doors open for one minute.
 - g. Include information indicating who will provide emergency service and perform post contract maintenance.
 - h. Provide a replacement parts list with current prices. Include a list of recommended spare parts, tools, and instruments for testing and maintenance purposes.
 - i. A computerized preventive maintenance schedule for all equipment. The schedule shall be provided on disk in a computer format acceptable to the VAMC and shall describe the protocol for preventive maintenance of all equipment. The schedule shall include the required times for systematic examination, adjustment and cleaning of all equipment. A print out of the schedule shall also be provided in the manual. Provide the disk in a pocket within the manual.
 - j. Furnish manuals in 3 ring loose-leaf binder or manufacturer's standard binder.
 - k. A print out for all devices proposed on each signaling line circuit with spare capacity indicated.
2. Two weeks prior to final inspection, deliver four copies of the final updated maintenance and operating manual to the COR.

- a. The manual shall be updated to include any information necessitated by the maintenance and operating manual approval.
 - b. Complete "As installed" wiring and schematic diagrams shall be included that shows all items of equipment and their interconnecting wiring. Show all final terminal identifications.
 - c. Complete listing of all programming information, including all control events per device including an updated input/output matrix.
 - d. Certificate of Installation as required by NFPA 72 for each building. The certificate shall identify any variations from the National Fire Alarm Code.
 - e. Certificate from equipment manufacturer assuring compliance with all manufacturers installation requirements and satisfactory system operation.
3. Together with the shop drawing submittal, submit the technician's NICET level III fire alarm certification as well as certification from the control unit manufacturer that the proposed performer of contract maintenance is an authorized representative of the major equipment manufacturer. Include in the certification the names and addresses of the proposed supervisor of installation and the proposed performer of contract maintenance. Also include the name and title of the manufacturer's representative who makes the certification.
 4. Together with the shop drawing submittal, submit a certification from either the control unit manufacturer or the manufacturer of each component (e.g., smoke detector) that the components being furnished are compatible with the control unit.
 5. Together with the shop drawing submittal, submit a certification from the major equipment manufacturer that the wiring and connection diagrams meet this specification, UL and NFPA 72 requirements.

1.5 WARRANTY

All work performed and all material and equipment furnished under this contract shall be free from defects and shall remain so for a period of five (5) years from the date of acceptance of the entire installation by the Contracting Officer's Technical Representative (COR).

1.6 APPLICABLE PUBLICATIONS

- A. The publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. The publications are referenced in text by the basic designation only.

- B. National Fire Protection Association (NFPA):
 - 70-2011.....National Electrical Code (NEC).
 - 72-2002.....National Fire Alarm Code.
 - 90A-2002.....Installation of Air Conditioning and Ventilating Systems.
 - 101-2003.....Life Safety Code
- C. Underwriters Laboratories, Inc. (UL):
 - 2000-2000.....Fire Protection Equipment Directory
- D. Factory Mutual Research Corp (FM): Approval Guide, 2005 Edition
- E. American National Standards Institute (ANSI):
 - S3.41-1996.....Audible Emergency Evacuation Signal
- F. International Code Council, International Building Code (IBC) 2003 Edition

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. This specification is based on a fire alarm system manufactured and distributed locally by SimplexGrinell, 248-427-5050 extension 5130, Mr. Tom Martin.

2.2 EQUIPMENT AND MATERIALS, GENERAL

- A. All equipment and components shall be new and the manufacturer's current model. All equipment shall be tested and listed by Underwriters Laboratories, Inc. or Factory Mutual Research Corporation for use as part of a fire alarm system. The authorized representative of the manufacturer of the major equipment shall certify that the installation complies with all manufacturers' requirements and that satisfactory total system operation has been achieved.

2.3 CONDUIT, BOXES, AND WIRE

- A. Conduit shall be in accordance with Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS and as follows:
 - 1. All new conduit shall be installed in accordance with NFPA 70.
 - 2. Conduit fill shall not exceed 40 percent of interior cross sectional area.
 - 3. All new conduit shall be 19 mm (3/4 inch) minimum.
- B. Wire:
 - 1. All existing wiring shall be removed in renovated area and new wiring installed in a conduit or raceway.
 - 2. Wiring shall be in accordance with NEC article 760, Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW), and as recommended by the manufacturer of the fire alarm

system. All wires shall be color coded. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 18 AWG for initiating device circuits and 14 AWG for notification device circuits.

C. Terminal Boxes, Junction Boxes, and Cabinets:

1. Shall be galvanized steel in accordance with UL requirements.
2. All new and reused boxes shall be sized and installed in accordance with NFPA 70.
3. New and existing covers shall be repainted red in accordance with Section 09 91 00, PAINTING and shall be identified with white markings as "FA" for junction boxes and as "FIRE ALARM SYSTEM" for cabinets and terminal boxes. Lettering shall be a minimum of 19 mm (3/4 inch) high.
4. Terminal boxes and cabinets shall have a volume 50 percent greater than required by the NFPA 70. Minimum sized wire shall be considered as 14 AWG for calculation purposes.
5. Terminal boxes and cabinets shall have identified pressure type terminal strips and shall be located at the base of each riser. Terminal strips shall be labeled as specified or as approved by the COR.

2.4 ALARM NOTIFICATION APPLIANCES

A. Chimes\Strobe:

1. Operates over a two wire Simplex SmartSync circuit.
2. Chime activation of Temporal pattern, March Time or on continuously.
3. Strobe appliance on the same circuit operating at a synchronized 1 Hz flash rate.
4. Strobe: Xeon intensity is selectable from 15, 30, 75 or 110 candela with visible selection jumper secured behind strobe housing. Strobes shall be synchronized where required by the National Fire Alarm Code (NFPA)

B. Strobes:

1. Xenon flash tube type. Xeon intensity is selectable from 15, 30, 75 or 110 candela with visible selection jumper secured behind strobe housing. Strobes shall be synchronized where required by the National Fire Alarm Code (NFPA 72).
2. Backplate shall be red with 13 mm (1/2 inch) permanent red letters. Lettering to read "Fire", be oriented on the wall or ceiling properly, and be visible from all viewing directions.
3. Each strobe circuit shall have a minimum of twenty (20) percent spare capacity.

2.5 ALARM INITIATING DEVICES

A. Manual Fire Alarm Stations:

1. Shall be non-breakglass.
2. Station front shall be constructed of a durable material such as cast or extruded metal or high impact plastic. Stations shall be semi-flush type.
3. Stations shall be of single action pull down type with suitable operating instructions provided on front in raised or depressed letters, and clearly labeled "FIRE".
4. Operating handles shall be constructed of a durable material. On operation, the lever shall lock in alarm position and remain so until reset. A key shall be required to gain front access for resetting, or conducting tests and drills.
5. Unless otherwise specified, all exposed parts shall be red in color and have a smooth, hard, durable finish.

B. Smoke Detectors:

1. Smoke detectors shall be UL listed for use with the fire alarm control unit being furnished.
2. Smoke detectors shall be non-addressable type complying with applicable UL Standards for system type detectors. Smoke detectors shall be installed in accordance with the manufacturer's recommendations and NFPA 72.
3. Detectors shall have an indication lamp to denote an alarm condition. Provide remote indicator lamps and identification plates where detectors are concealed from view. Locate the remote indicator lamps and identification plates flush mounted on walls so they can be observed from a normal standing position.
4. All spot type and duct type detectors installed shall be of the photoelectric type.
5. Photoelectric detectors shall be factory calibrated and readily field adjustable. The sensitivity of any photoelectric detector shall be factory set at 3.0 plus or minus 0.25 percent obscuration per foot.
6. Detectors shall provide a visual trouble indication if they drift out of sensitivity range or fail internal diagnostics. Detectors shall also provide visual indication of sensitivity level upon testing. Detectors, along with the fire alarm control units shall be UL listed for testing the sensitivity of the detectors.

C. Heat Detectors:

1. Heat detectors shall be UL listed for use with the fire alarm control unit being furnished restorable rate compensated fixed-temperature spot type.

2. Detectors shall have a minimum smooth ceiling rating of 2500 square feet.

D. Water Flow and Pressure Switches:

1. Wet pipe water flow switches and dry pipe alarm pressure switches for sprinkler systems shall be connected to the fire alarm system.
2. All new water flow switches shall be of a single manufacturer and series and non-accumulative retard type.
3. All new switches shall have an alarm transmission delay time that is conveniently adjustable from 0 to 60 seconds. Initial settings shall be 30-45 seconds. Timing shall be recorded and documented during testing.

2.6 SUPERVISORY DEVICES

A. Duct Smoke Detectors:

1. Duct smoke detectors shall be UL listed for use with the fire alarm control unit being furnished. Detectors shall be provided with an approved duct housing mounted exterior to the duct, and shall have perforated sampling tubes extending across the full width of the duct (wall to wall). Detector placement shall be such that there is uniform airflow in the cross section of the duct.
2. Interlocking with fans shall be provided in accordance with NFPA 90A and as specified hereinafter under Part 3.2, "TYPICAL OPERATION".
3. Provide remote indicator lamps, key test stations and identification nameplates (e.g. "DUCT SMOKE DETECTOR AHU-X") for all duct detectors. Locate key test stations in plain view on walls or ceilings so that they can be observed and operated from a normal standing position.

2.7 SMOKE BARRIER DOOR CONTROL

A. Electromagnetic Door Holders:

1. New Door Holders shall be standard wall mounted electromagnetic type. In locations where doors do not come in contact with the wall when in the full open position, an extension post shall be added to the door bracket.
2. Operation shall be by 24 volt DC supplied from a battery located at the fire alarm control unit. Door holders shall be coordinated as to voltage, ampere drain, and voltage drop with the battery, battery charger, wiring and fire alarm system for operation as specified.

B. A maximum of twelve door holders shall be provided for each circuit.

Door holders shall be wired to allow releasing doors by smoke zone.

C. Door holder control circuits shall be electrically supervised.

D. Smoke detectors shall not be incorporated as an integral part of door holders.

2.8 UTILITY LOCKS AND KEYS:

- A. All key operated test switches, control units, annunciator panels and lockable cabinets shall be provided with a single standardized utility lock and key.
- B. Key-operated manual fire alarm stations shall have a single standardized lock and key separate from the control equipment.
- C. All keys shall be delivered to the COR.
- D. Provide to the VA, all hardware, software, programming tools, license and documentation necessary to permanently modify the fire alarm system on site. The minimum level of modification includes addition and deletion of devices, circuits, zones and changes to system description, system operation, and digitized evacuation and instructional messages.

PART 3 - EXECUTION**3.1 INSTALLATION:**

- A. Installation shall be in accordance with NFPA 70, 72, 90A, and 101 as shown on the drawings, and as recommended by the major equipment manufacturer. Fire alarm wiring shall be installed in conduit. All conduit and wire shall be installed in accordance with Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS , Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW), and all penetrations of smoke and fire barriers shall be protected.
- B. All new conduits, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. All existing accessible fire alarm conduit not reused shall be removed.
- C. All new or reused exposed conduit shall be painted in accordance with Section 09 91 00, PAINTING to match surrounding finished areas and red in unfinished areas.
- D. Existing devices that are reused shall be properly mounted and installed. Where devices are installed on existing shallow backboxes, extension rings of the same material, color and texture of the new fire alarm devices shall be used. Mounting surfaces shall be cut and patched in accordance with Section 01 00 00, GENERAL REQUIREMENTS, Restoration, and be re-painted in accordance with Section 09 91 00, PAINTING as necessary to match existing.
- E. All fire detection and alarm system devices, control units shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.

- F. Chime\Strobes and Strobes shall be flush wall mounted 2,000 mm (80 inches) above the floor or 150 mm (6 inches) below ceiling, whichever is lower. Locate and mount to maintain a minimum 900 mm (36 inches) clearance from side obstructions.
- G. Manual pull stations shall be installed not less than 1050 mm (42 inches) or more than 1200 mm (48 inches) from finished floor to bottom of device and within 1500 mm (60 inches) of a stairway or an exit door.
- H. Where possible, locate water flow and pressure switches a minimum of 300 mm (12 inches) from a fitting that changes the direction of the flow and a minimum of 900 mm (36 inches) from a valve.
- I. Mount valve tamper switches so as not to interfere with the normal operation of the valve and adjust to operate within two revolutions toward the closed position of the valve control, or when the stem has moved no more than one-fifth of the distance from its normal position.

3.2 TESTS

- A. Provide the service of a NICET level III, competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and tests for the system. Make all adjustments and tests in the presence of the COR.
- B. When the systems have been completed and prior to the scheduling of the final inspection, furnish testing equipment and perform the following tests in the presence of the COR. When any defects are detected, make repairs or install replacement components, and repeat the tests until such time that the complete fire alarm system meets all contract requirements. After the system has passed the initial test and been approved by the COR, the contractor may request a final inspection.
 - 1. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
 - 2. Test the insulation on all installed cable and wiring by standard methods as recommended by the equipment manufacturer.
 - 3. Run water through all flow switches. Check time delay on water flow switches. Submit a report listing all water flow switch operations and their retard time in seconds.
 - 4. Open each alarm initiating and notification circuit to see if trouble signal actuates.
 - 5. Ground each alarm initiation and notification circuit and verify response of trouble signals.

3.3 FINAL INSPECTION AND ACCEPTANCE

- A. Prior to final acceptance a minimum 30 day "burn-in" period shall be provided. The purpose shall be to allow equipment to stabilize and potential installation and software problems and equipment malfunctions to be identified and corrected. During this diagnostic period, all system operations and malfunctions shall be recorded. Final acceptance will be made upon successful completion of the "burn-in" period and where the last 14 days is without a system or equipment malfunction.
- B. At the final inspection a factory trained representative of the manufacturer of the major equipment shall repeat the tests in Article 3.3 TESTS and those required by NFPA 72. In addition the representative shall demonstrate that the systems function properly in every respect. The demonstration shall be made in the presence of a VAMC representative.

- - - END - - -

APPENDIX

TAB 1
VA INTERIOR SIGNAGE



Department of Veterans Affairs

Veterans Health Administration
Washington, DC 20420

VA Signage Design Guide

PREPARED BY

e n g l u n d

D E S I G N W O R K S i n c .
1523



VA Signage Design Guide



Trim width of
paper to match
spine width of
binder pocket.



Department of Veterans Affairs

Veterans Health Administration
Washington, DC 20420

VA Signage Design Guide

PREPARED BY

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D E S I G N W O R K S i n c .
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▪ Introduction	
▪ Acknowledgments	
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▪ Parking Lots & Parking Structures	Section 3
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Introduction

This Signage Design Guide updates the previous Environmental Graphics Design Program Guide published in September 1996.

It provides guidelines for the design of signs and provides detailed information on the development of a signage system to assist VA veteran customers, visitors, and others as they approach the property, locate buildings, and proceed to functions inside.

The Signage Design Guide has been completely updated. These revisions are the result of regulatory changes, including UFAS, ADAG, and NFPA, expansion and growth of VA facilities, procedural changes, and practical knowledge gained from field experience. Complete new sections have been added to address the needs of VA facilities considering both small room renumbering programs and/or a complete upgrade of their existing signage. These sections inform program officials, planners, and designers how to identify the need for a signage program and steps on interviewing and selecting an environmental graphics design firm. It also includes an in depth section on parking lots and parking structures. The following are highlights in both the updated sections and the newly added sections:

- Updates to facility names on site identification signs, including consolidated Medical Centers, Congressionally named facilities, combined VHA and VBA facilities, outpatient clinics, community based outpatient clinics, and VBA regional offices;
- Expanded construction details for exterior signs;
- A new section, "Parking Lots and Parking Structures". This section includes signs, details, construction, and installation specifications;
- Special sub-sections devoted to National Cemetery signs;
- A new section on room re-numbering with criteria and implementation on room re-numbering as well as offering suggestions on fixing "broken" room numbering systems;
- Signage related to a HopTel;
- A new section titled, "Need a New Sign Program" that assists a facility in the project process from beginning to end, including all the steps from identifying the need for a new sign program through implementing the new program. Subsections include sample questions for interviewing a prospective Environmental Graphics Design Firm, rating factors, sample of Statement of Work, etc.; and
- Various interior and exterior sign types and their specifications, construction, and installation guidelines;
- Mandatory VA policy signs that contain specific text, layout, size, placement, and location requirements that cannot be altered or changed;
- Expanded Code & Life Safety signs section that includes a pictorial for installation of stairwell signs and other associated signs;
- Specialty signs that include freestanding signs for display of various information, card and file holders, and door knob signs for multipurpose uses;
- Examples of marquee signs that incorporate electronic messages;

This has been a collaborative effort, with extensive input from VAMC and VISN officials, VACO program officials including designers, fire and safety, security and law enforcement professionals, and other Veterans Health Administration, National Cemetery Administration, and Veterans Benefits Administration staff. This will be a living document that will be periodically updated. When significant changes do occur, "Design Alerts" will be e-mailed with the included changes.

Lloyd H. Siegel, FAIA Associate Chief Facilities Management Officer for Strategic Management
August 2005

Acknowledgments

This program guide for the Department of Veterans Affairs has involved input and work from central VA, the three Administrations, VA Medical Centers, many departments, and individuals. Particular thanks are expressed to the following special participants during the preparation of this guide and acknowledges their very lasting deliberations, hard work, and thoughtful enthusiasm:

Ken Backer	Health System Specialist VISN 5 VA Capitol Health Care Network
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Orest Burdiak	Lead Interior Designer VAMC West Side, Chicago, Illinois
Ken Carrico	Project Manager Veterans Benefits Administration
Kevin Doyle	Criminal Investigator VA Security and Law Enforcement
Ken Faulstich	Safety & Fire Protection Engineer Veterans Health Administration
Keith Frost	Security Specialist VA Security and Law Enforcement
Lewis Sinclair	Architect National Cemetery Administration
Design Consultant	Englund Designworks Inc. Pleasant Hill, California



Design Elements

- Typeface
- Letterspacing
- Logo Signature
- Seal
- Arrow
- Colors
- Metric
- Languages

The Department of Veterans Affairs sign system has been designed using a selected group of common graphic elements and visual standards.

The graphic elements include the Department of Veterans Affairs logo signature and seal, three versions (weight and style) of the Helvetica typeface and specifications for letter and word spacing. Visual standards include: colors and finishes, and letter size in relation to viewing distance.

These standards become the component building blocks around which signs are configured. They have been adopted to provide a functional consistency in signs for the Department of Veterans Affairs.

If specialized or unique sign applications require deviation from these standards, as applied to signs, contact the Department of Veterans Affairs, Facilities Management or Environmental Management Services.

Typeface

Helvetica Medium is the standard typeface for the VA Sign System and will be used predominantly throughout the sign program. Signs identifying permanent rooms shall be in all caps with accompanying Grade 2 Braille. All other signs are to maintain an upper and lower case (Initial Caps) format.

Overhead signs shall be Helvetica Condensed Medium.

The secondary language of a multilingual sign shall be Helvetica Regular.

Building Standard - Helvetica Bold

ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz
1234567890

Second Language - Helvetica Regular

ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz
1234567890

Overhead Signs - Helvetica Bold Condensed

ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz
1234567890

Letterspacing

Normal letter spacing is utilized when the readability ratio factor (capital letter height in inches to maximum readable viewing distance in feet) is 1:25 for a word using upper and lower case letters. Word spacing shall be equivalent to the width of a lower case "v".

Normal letter spacing should not be used when letter forms are to be illuminated as light bleed causes letters to fuse together visually.

Distance letter spacing shall be utilized when the copy content is intended for readability at greater viewing distances than normal letter spacing allows. The readability ratio factor is 1:40. Distance letter spacing shall be used for all exterior & illuminated signs.

Normal Spacing

Correct Spaci	Spaci i i	Spaci i loose
Ad i i i	i i i	i i i
i	i i i	i i loose
Ad i i i	i i i	i i i
i i		
i	Spaci i i	Spaci i loose
B il i	il i	il i
i	Spaci i i	Spaci i loose
B il i	il i	il i

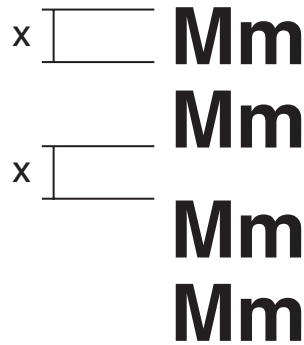
Interline Spacing

Interline spacing will generally be noted on sign type drawings. As a rule, line spacing shall be no less than 1/2 the height of the upper case letter form.



Paragraph Spacing

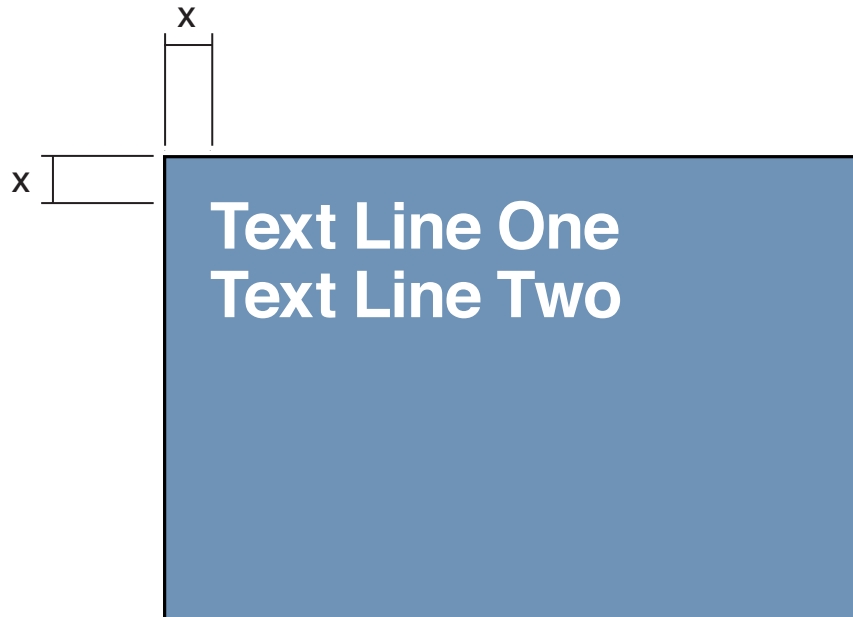
Paragraph spacing will generally be noted on sign type drawings. As a rule, paragraph spacing shall be no less than the height of the upper case letter form.



Alignment

A flush upper left copy format shall be the general rule though certain exceptions shall be noted.

As a rule, all copy placed on inserts, changeable directional modules, listing strips, overhead panels, and changeable exterior panels shall be vertically centered, (equal margins top and bottom) Graphic symbols used in square format shall be centered on four sides.

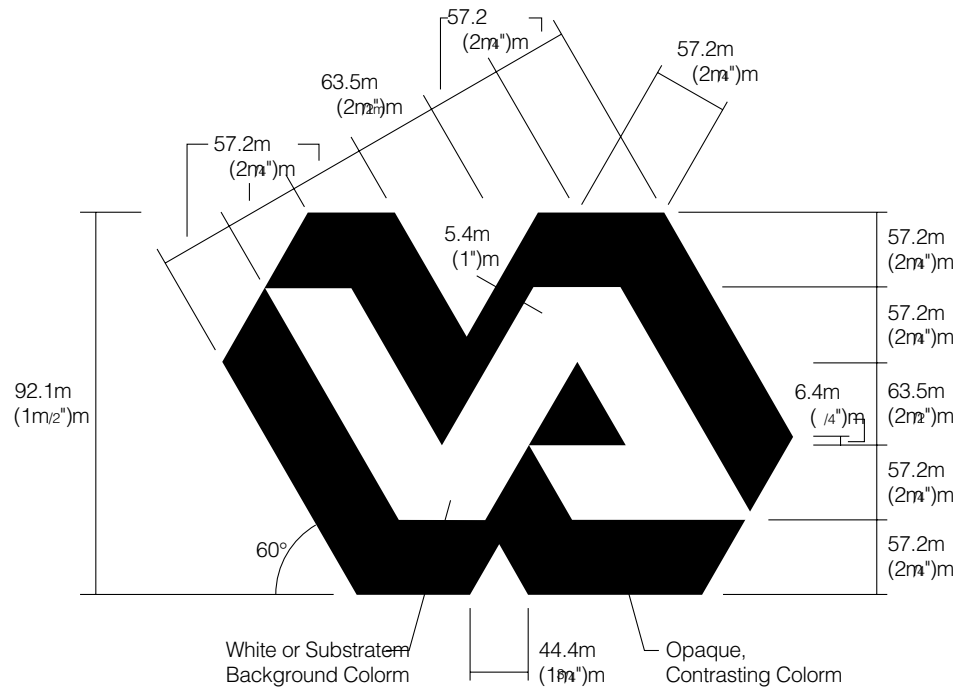


X - Dimensions varies per sign type.
See Sign Type Drawings for exact dimensions

Signature

The signature which includes the VA logo icon and the text shall be presented in a manner consistent with the Department of Veterans Affairs Graphic Standards.

Adjacent configuration are those that are typically acceptable for use with the logo icon. If other configurations of the name and logo icon are desired consult with Washington, DC for prior approval.



Seal

Adjacent illustrations show the two versions of the Department of Veterans Affairs seal.

The seal is for use on the exterior of the main building of a medical center, or within the main lobby of a Department of Veterans Affairs facility or office.

Refer to VA Technical Information Library on the VA web site for more information on the seal. All seals must conform to master art work which is available from the Department of Veterans Affairs.

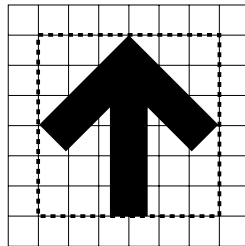


Note: The seal is not to be used on signs.

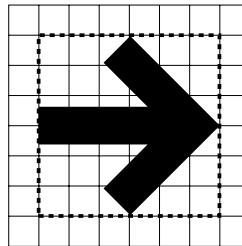
Arrow

Illustrations show the prescribed arrow for use in the VA sign program.

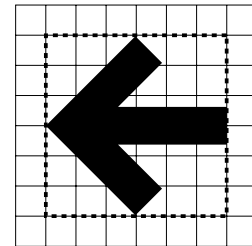
The arrow is always centered within its square field.



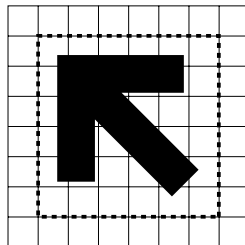
POSITION 1



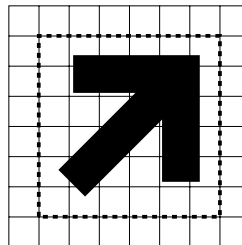
POSITION 2



POSITION 3



POSITION 4



POSITION 5

Arrow Alignment with Text

The arrow is always positioned in such a manner that it is centered in relationship to the capital letter that it precedes. The standard position for arrows, in relationship to text, is either on the left of the first line of text or immediately above the first line of text.

On signs with numerous destinations a single arrow will be placed adjacent to the first line of text to identify the direction for all destinations grouped together.

The arrow size is one and one half (1 1/2) times the capital letter height.



Sign Colors

The adjacent chart and accompanying illustrations provide a listing of sign colors that allow a medical center to coordinate an interior or exterior sign program to the architectural colors and finishes of the buildings on the campus.

All colors listed, are identified by their Pantone codes. These codes were created using the Pantone Formula Guide Solid Uncoated color matching system, which can be found and matched to their CMYK on the Pantone web site: www.Pantone.com.

The color options listed have been selected because they provide contrast between typography and the sign background. Contrast for exterior signs is important for both day and night readability from vehicles. Exterior signs that are not internally illuminated should have reflective white letters.

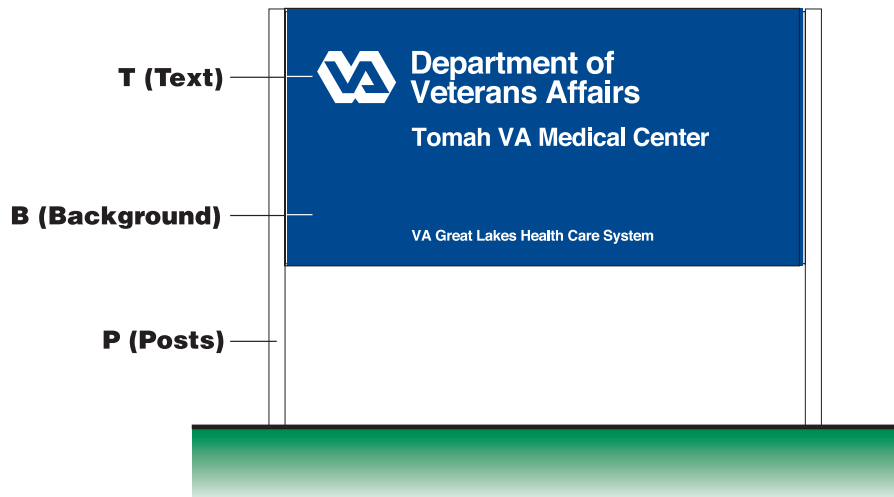
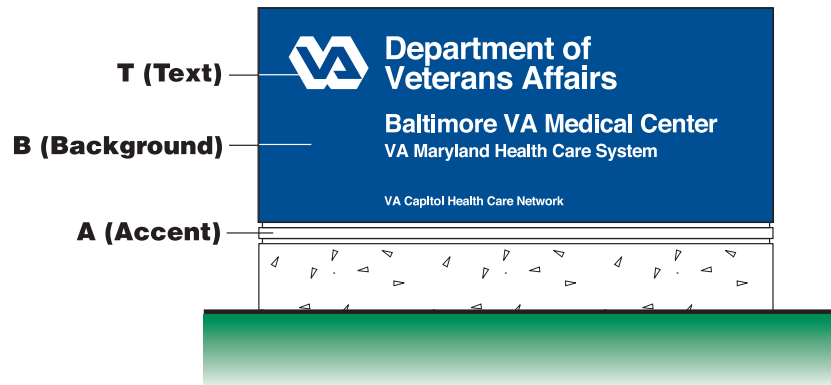
High contrast for readability is equally important for interior signs, especially for the elderly and vision impaired. Light background colors need black or dark gray text and deep or dark colors need white text.

If a facility deviates from the identified family of colors, they should insure that there is sufficient contrast between the typography and sign background under all lighting situations.

Night and day light conditions for exterior signs can vary a lot so readability should be field verified with actual color samples.

Placement, type of light fixture, sodium and halide lights, warm and cool florescent lights can also change colors and effect contrast so this also needs to be taken into account.

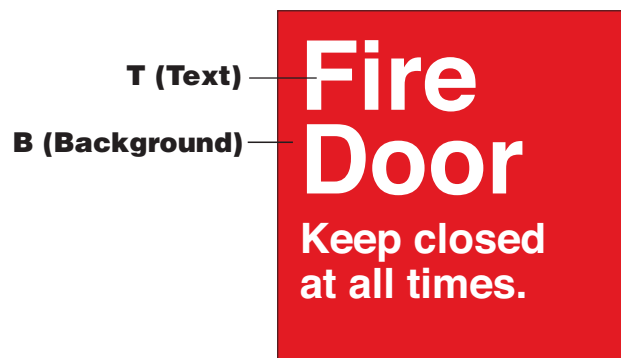
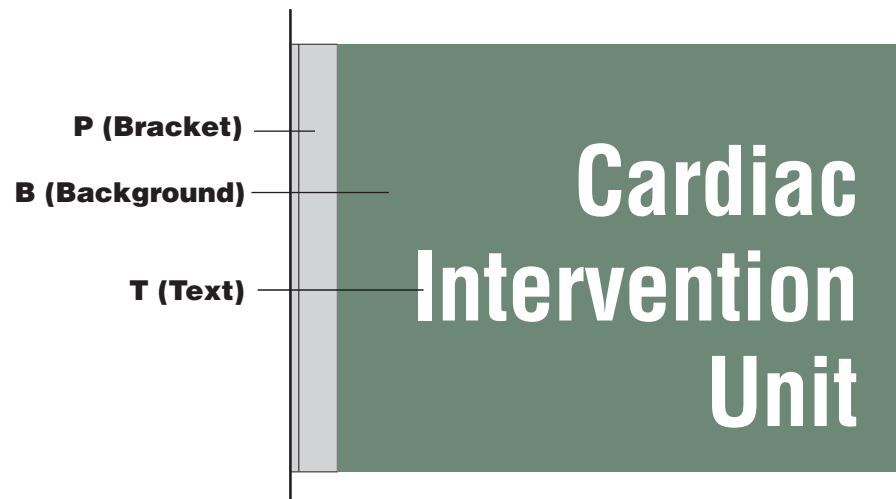
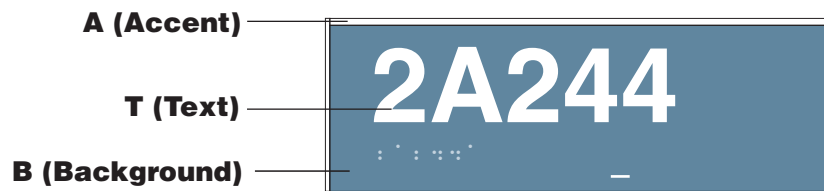
Some of the colors listed can be used for both interior and exterior applications and are so indicated. There are however certain colors that should not be used for interior or exterior signs because of their unsuitability or because they are only for special applications.









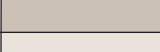







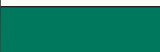

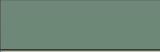


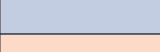

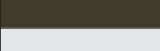





Exterior Sign Background ColorsC

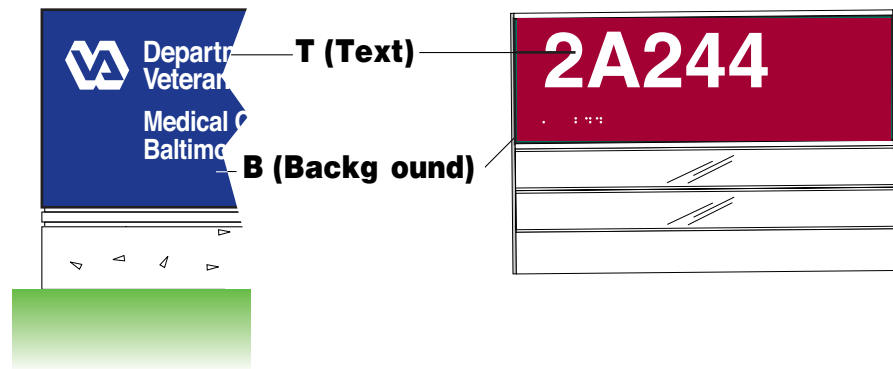
	Color Description	Color #	Color	Pantone #	Recommended Text Color to use
Exterior Background Colors	Dark Bronze Anodized 313	B1		--	T1 T2 T3
	Handicapped Blue (Fed #15090)	B2		308U	T1 T2
	Red (OSHA)	B3		1797U	T1 T2 T3
	VA Blue (PMS 280)	B4		280U	T1 T2 T3
	Dark Brown	B5		497U	T1 T2 T3
	Black	B6		BlackU	T1 T2 T3
	White	B7		--	Refer to Parking Garage Text Colors
	Yellow (OSHA)	B8		108U	T4
	Graphite	B9		419U	T1 T2 T3
	Dark Blue	B12		295U	T1 T2 T3
	Burgundy	B13		195U	T1 T2 T3
	Teal	B14		3165U	T1 T2 T3
	Dark Green	B15		3302U	T1 T2 T3
	Brick	B16		1955U	T1 T2 T3
	Blue Gray	B17		5415U	T1 T2 T3
	Orange	B18		165U	T1 T2 T3
	Forest Green	B19		342U	T1 T2 T3
	Adobe	B20		479U	T1 T2 T3
	Sage Green	B21		5625U	T1 T2 T3
Exterior Posts	Dark Bronze Anodized 313	P1			
	Clear Anodized	P2			
	White	P3			
Accent	Polished Aluminum	A1			
	Satin Aluminum	A2			

Sign manufacturers may already have product available in some of these colors. Each of the background colors can be custom mixed to match in different types of paint based upon the various application requirements and specifications. Besides these colors, all traffic sign faces should use the prescribed colors as listed in the Manual for Uniform Traffic Control Devices. All OSHA Safety Colors are to meet ANSI specification Z53.1/OSHA.



Interior Sign Background ColorsC

	Color Description	Color #	Color	Pantone #	Recommended Text Color to use
Interior Background Colors	Red (OSHA)	B3		1797U	T1 T4
	Dark Brown	B5		497U	T1
	Black	B6		Black U	T1
	White	B7			T4 T5 T6 T8
	Yellow (OSHA)	B8		108U	T4 T5 T7
	Graphite	B9		419U	T1
	Gray	B10		401U	T4 T5
	Putty	B11		Warm Gray 3U	T4 T5
	Dark Blue	B12		295U	T1
	Burgundy	B13		195U	T1
	Teal	B14		3165U	T1
	Dark Green	B15		3302U	T1
	Brick	B16		1955U	T1
	Blue Gray	B17		5415U	T1 T6
	Antique White	B18		Warm Gray 1U	T4 T5
	Forest Green	B19		342U	T1 T2 T3
	Adobe	B20		479U	T1 T2 T3
	Sage Green	B21		5625U	T1 T2 T3
	Taupe	B22		4735U	T1 T4 T5
	Light Green	B23		5503U	T1 T4 T5
	Light Blue	B24		537U	T1 T4 T5
	Mauve	B25		7513U	T4 T5
End Caps rackets Stanchions	Dark Bronze Anodized 313	P1			
	Clear Anodized Aluminum	P2			
	Black	P4		Black U	
Accent	Polished Aluminum	A1			
	Satin Aluminum	A2			



Exterior & Interior Text ColorsC

	Color Description	Color #	Color	Pantone #	Recommended Background Color to use
Exterior Text Color	Gloss White	T1			B1, B2, B3, B4, B6, B9, B12, B13, B14, B15, B16, B17
	Refelective White	T2			B1, B2, B3, B4, B6, B9, B12, B13, B14, B15, B16, B17
	Translucent White	T3			B1, B3, B4, B6, B9, B12, B13, B14, B15, B16, B17
Interior Text Color	Gloss White	T1			B3, B5, B6, B9, B12, B13, B14, B15, B16, B17, B18, B19, B20
	Black	T4		Black U	B3, B7, B8, B10, B11, B18, B19, B20, B21
	Graphite	T5		419U	B7, B8, B10, B11, B18, B19, B20, B21
	Red	T6		1797U	B7, B17
	Purple	T7		2425U	B8

For parking garage signs, vinyl colors will be applied to either white or one of the other exterior paint colors. The vinyl color should match the sign accent background exterior paint color. The colors and their respective numbers listed in the chart below accurately match the VA exterior sign paint colors. The vinyls are part of the High Performance Opaque Series by Avery Graphics.



Parking Garage Structure Text Colors Colors

	Color Description	Color #	Color	Pantone #	Recommended Background Color to use
Parking Garage Structure Vinyl Text Colors	Gloss White	T1		--	B3, B4, B12, B13, B14, B15, B16, B17
	A8525-0 Majestic Blue	T8		295U	B7 (White)
	A8520-0 Shadow Blue	T9		5415U	B7 (White)
	A8370-0 Burgundy	T10		195U	B7 (White)
	A8580-0 Sapphire Blue	T11		280U	B7 (White)
	A8690-0 Deep Green	T12		3302U	B7 (White)
	A8350-0 Dark Red	T13		1955U	B7 (White)
	A6835-0 Nautical Blue	T14		3165U	B7 (White)
	A8345-0 Fire Red	T15		187U	B7 (White)

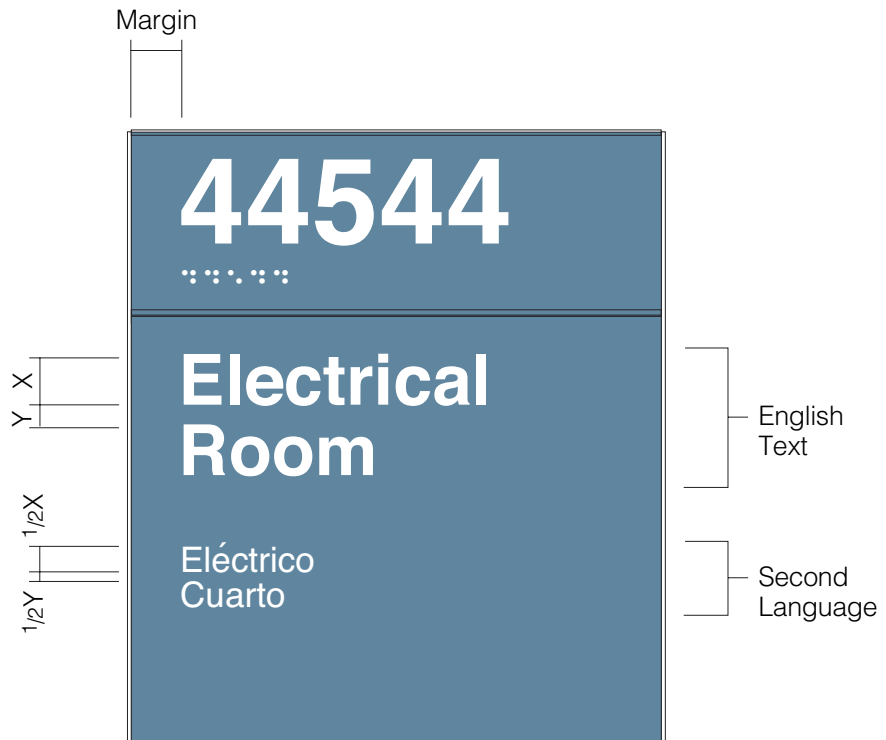
Second Language

The cap height of the English text (see Sign Type Drawings for this dimension) is the basis for determining the cap height of the second language text.

Unless otherwise noted, the second language text is 1/2 the size of the English text.

Unless otherwise noted, the interline spacing of the second language text is 1/2 the interline spacing of the English text.

The second language margin is the same as the margin used for the English text and braille. See the Sign Type Drawings for this dimension.



Metric

The metric system is the preferred system of measurement in accordance with the Metric Conversion Act of 1975, P.L. 94-168, as amended by Section 5164 of Omnibus Trade & Competitiveness Act of 1988 Executive Order 12770.

In accord with the Department of Veteran Affairs metric conversion plan, the sign system is recommended to be constructed in metric, however the English system can be used on VA projects, if it meets the needs of a specific facility. The use of metric should not add cost to a project and "off the shelf" metric sign systems are preferred.

The VA does not intend to impose rigid metric conversions on the sign industry and will support sign manufacturers as their industry converts to the metric standard.

For assistance in transition to metric, the drawings with dimensions have been prepared showing direct metric English conversion. While typography is generally referred to in the graphic industry by point sizes and the sign industry in inches, the VA sign program is showing text layouts developed in inches and then directly converted to metric. It is preferred however, that metric dimensions be rounded to the nearest 1 mm up to 1 inch; 5 mm up to 4 inches; and, above 4 inches rounded to the nearest 25 mm.

The adjacent conversion chart should provide assistance in determining conversions from inches to millimeters.

For further information on the conversation to metric, contact the Department of Veteran Affairs, Facilities Management Office.

Inches	Nearest 9 1 mm9 (1/25")9	Nearest 9 5 mm9 (1/5")9	Nearest 9 5 mm 9 (2/5")9	1"= 25mm9 EXACTLY9
1/32"	19			
1/16"	29			
3/32"	29			
1/8"	39			
3/16"	59			
1/4"	69			
5/16"	89			
3/8"	109			
7/16"	119			
1/2"	139			
9/16"	149			
5/8"	169			
3/4"	19			
7/8"	229			
1"	259	259		
1 1/4"	329	309		
1 1/2"	389	409		
1 3/4"	449	459		
2"	519	509		
2 1/4"	579	559		
2 1/2"	649	659		
2 3/4"	709	709		
3"	769	759		
3 1/4"	839	85		
3 1/2"	89	0		
3 3/4"	59	59		
4"	1029	1009	1009	1009
5"	1279	1259	1309	1259
6"	1529	1509	1509	1509
7"	1789	1809	1809	1759
8"	2039	2059	2009	2009
9"	229	2309	2309	2259
10"	2549	2559	2509	2509
11"	279	2809	2809	2759
1'-0"	3059	3059	3009	3009
2'-0"	6109	610	610	600
3'-0"		159	109	009
4'-0"		12209	12209	12009
5'-0"		15259	15209	15009
6'-0"		18309	18309	18009
7'-0"		21359	21309	21009
8'-0"		24409	24409	24009
9'-0"		27459	27409	27009
10'-0"		30509	30509	30009
15'-0"		45709	45709	45009
20'-0"		60959	61009	60009



Code & Life Safety Signs

- Fire
- Evacuation
- Elevator
- Exit
- Door
- Caution
- Warning

Section 5: Code & Life Safety Signs

▪ Planning	Pages 5-2-1 through 5-2-2
▪ Helpful Hints	Pages 5-3-1
▪ Overview	Pages 5-4-1 through 5-4-4
▪ Code & Life Safety Signs	Pages 5-5-1 through 5-5-70
▪ Specification	Pages 5-6-1
▪ Construction	Pages 5-7-1
▪ Installation	Pages 5-8-1 through 5-8-5

Planning a Life Safety and Code Sign Program

The development of an effective working Life Safety and Code sign program requires the coordination of several interlaced criteria.

For an effective interior sign program you have to take in to account to the following:

1. Location of building entrances, exits and elevators.
2. Character and configuration of the corridor system.
3. How do visitors currently walk around the building(s).
4. What is the desired path of emergency egress travel within the building for visitors, patients and employees.
5. Location of emergency equipment.
6. Placement of signs in locations where people are expecting them to be or the code requires to be.
7. OSHA and other regulatory agency sign requirements
8. Which signs can have permanent messages and which ones need to be changeable.

These elements help establish the basis of a clear sign program that communicates and informs in a direct and simple manner.

Types of Signs

Life Safety and Code signs have been identified, on each page, with description of use and application. Life Safety and Code signs are in the color, size and shape to conform with their respective functioning and application requirement.

regulations are constantly changing so new and updated signs may be required for current conformance.

Consult with your facility Safety Officer for any revised sign requirements.

This section covers the known required signs at the time of publication, but

Sizes of Signs & Lettering

Life Safety and Code sign sizes that are illustrated in this section have been determined to work in most situations and conform to regulations.

The text and its size, as shown, has been determined to conform to regulations.

Placement of Signs Correct placement of signs is required for Life Safety and Code signs. Refer to the detailed drawings and instructions covered in the Installation Section for each sign type showing the placement position required for its use.

Care needs to be taken to place Life Safety and Code signs in a manner that allow clear viewing. Placement of signs

so they are not obscured by furniture or equipment is critical.

Coordination needs to take place with things like chart holders, bulletin boards, pictures and art work as these types of items will have to be relocated to meet the installation requirements of Life Safety and Code signs.

Existing Sign Program Before implementing a new Life Safety and Code sign program, perform a thorough evaluation of the demolition requirements of the current Life Safety and Code sign program and the effects and impact on the facilities walls, doors and ceilings.

Check to see what is required to patch, seal and repair the building surfaces exposed as a result of removal of old signs. Repairs should be planned to match adjoining surface. Evaluate if tile or stone surfaces going to require repair

or refurbishment. Are doors going to need to be refinished or painted.

Make sure the sign demolition scope of work requires the contractor to close off any live electrical connections. Make sure to have existing conductors and conduit removed to the nearest junction box and made it safe.

Do not remove any Life Safety and Code signs without having the replacement signs available and installed at the same time the old signs are removed.

The following are some general “Do’s & Don’ts” guidelines that one can refer to when developing a Life Safety & Code sign program.

This is not intended to be a training

section of the guide, but to provide key information or instructions that will hopefully reduce some common errors that are made when working out a Life Safety & Code sign program.

General Guidelines

- Some Life Safety & Code have specific color requirements and they are not to be changed.
- When selecting a background color for the signs that don’t have a specific color requirement, seek a complementary color to the building wall colors and a color that conforms to the master sign program color.
- Signs do require maintenance. Cleaning will extend the life of a sign program.

Message Content

- Life Safety & Code signs have specific text requirements and should not be altered.
- There are other signs that have to have specific text developed for each sign location. Refer to the sign type drawings.

Message Layout

- Some Life Safety & Code signs have specific text layout requirements and they are not to be changed.

Size of Sign to Use

- Some Life Safety & Code signs have specific size requirements and they are not to be changed.

Placement of Signs

- Some Life Safety & Code signs have specific placement and location requirements and they are not to be changed.
- Be careful to coordinate ceiling mounted signs so they do not obstruct or block fire sprinkler systems.

This section of the Environmental Graphic Sign Handbook provides interior sign guides for all the types of Life Safety & Code signs that are necessary to sign any individual building, regardless of size or type of use.

The following Overview illustrates the various types of signs in this section. The individual pages on each Sign Type provide more specific information and detailed layouts.

Interior Sign Designations

Each sign in the program guide has been give a specific sign type number designation. This designation provide a common description that can be referenced when programming a site and ordering signs. The following explains how the sign type designations are derived.

IN-01.01.03C

IN Designates an interior sign.

-01 Two digit numbers identifies the Life Safety & Code sign family.

.28 The two digit number following the period identifies a specific sign type within the sign family.

.03 The two digit number following the period identifies a specific sub-group of sign within the sign family.

C The letter designates a specific sign configuration and/or layout for graphics or symbols.

Example: IN-01.01.02B

IN - Interior sign
01 - Life safety and code required signs
.01 - Specific sign
.02 - Sign sub-group
B - Specific type size layout

IN-01.01.01

Large Emergency Exit Plan

IN-01.01.02

Medium Emergency Exit Plan

IN-01.01.03

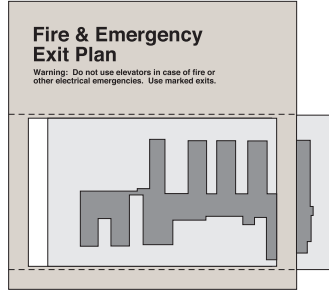
Small Emergency Exit Plan,
Hoptel Room Emergency Exit Plan

IN-01.02

Fire Equipment Identification Sign

IN-01.03

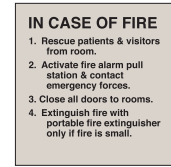
Fire Procedure Sign



IN-01.01.01, .02, & .03



IN-01.02



IN-01.03

IN-01.04

Elevator Call Button

IN-01.05

Fire Door Sign

IN-01.06

No Exit Sign



IN-01.04



IN-01.05



IN-01.06

IN-01.07.01

Exit Sign

IN-01.07.02

Exit Sign (Right Arrow)

IN-01.07.03

Exit Sign (Left Arrow)

IN-01.07.04

Exit Sign (Left & Right Arrows)



IN-01.07.01, .02, .03 & .04



IN-01.08



IN-01.09

IN-01.08

Automatic Fire Door (Hinged) Sign

IN-01.09

Automatic Fire Door (Roll Up) Sign

IN-01.10

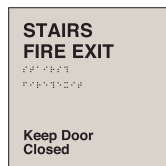
Stair Identification Sign

IN-01.11

Stairwell Identification Sign

IN-01.12

Area of Refuge (Evacuation Assistance)



IN-01.10



IN-01.11



IN-01.12

IN-01.13

Push Alarm Identification Sign

PUSH UNTIL
ALARM SOUNDS
DOOR CAN BE
OPENED IN 15
SECONDS

IN-01.13

THIS DOOR TO REMAIN
UNLOCKED WHEN THE
BUILDING IS OCCUPIED

IN-01.14

IN-01.15

Hazard Material Information Sign



IN-01.15

IN-01.16

Oxygen In Use Warning Sign

CAUTION
OXYGEN IN USE
NO SMOKING
NO OPEN FLAMES
Any material that can burn in
air will burn more rapidly in the
presence of oxygen. No
electrical equipment is allowed
within an oxygen enclosure or
within 5 ft. (1.5 m) of it.

IN-01.16

Warning

The following gases
in compressed
cylinders are present
in this laboratory:

Acetylene Helium
Nitrogen Nitric Oxide
Argon Hydrogen

IN-01.17

IN-01.18

Nonflammable Anesthesia
Restriction Sign

RESTRICTED TO
NONFLAMMABLE
INHALATION
ANESTHETIC
AGENTS

IN-01.18

IN-01.19

Radioactive Material Warning Sign



IN-01.19



IN-01.20

IN-01.20

Radioactive Area Warning Sign

IN-01.21

High Voltage Warning Sign



IN-01.21

IN-01.22

Biohazard Warning Sign



IN-01.22

IN-01.23

Laser Warning Sign



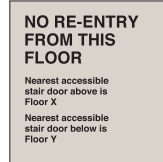
IN-01.23

IN-01.24

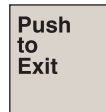
Occupational Exposure Area
Warning Sign



IN-01.24



IN-01.25



IN-01.26

IN-01.27

Emergency Push to Open Sign

IN-01.28

Emergency Slide to Open Sign

IN-01.29

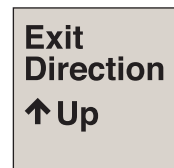
Direction of Exit Sign



IN-01.27



IN-01.28



IN-01.29

IN-01.30

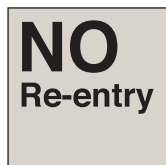
No Re-entry Sign

IN-01.31

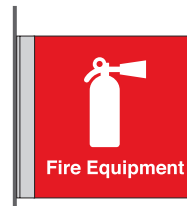
Fire Equipment Identification Sign

IN-01.32

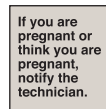
Pregnancy Notification Sign



IN-01.30



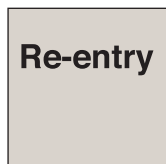
IN-01.31



IN-01.32

IN-01.33

Re-entry Sign



IN-01.33

Sign

508 mm H x 508 mm W
(20" H x 20" W)

Description & Use

Evacuation Map/Fire Exit Plan with pocket to accept map insert is to be placed at points of exit and transition in a building. All elevators, nurses stations and adjacent to stairwell doors. Other locations as needed. Evacuation maps (11" x 17" tabloid paper) can be created by the medical center and inserted in to the sign in accord with the evacuation plan relative to the specific location of the sign.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Face: Clear 1.5 mm (1/16") non-glare acrylic with subsurface background color creating a clear window.
Spacer to receive a clear .4 mm (1/64") insert with vinyl letters.
Backing Plaque: Surface painted 6 mm (1/4") acrylic.

Graphic Process

Sign: Silk-screened.
Insert: Printed

Colors

Type: Refer to Color Chart.
Background: Refer to Color Chart

Typography

Helvetica Medium

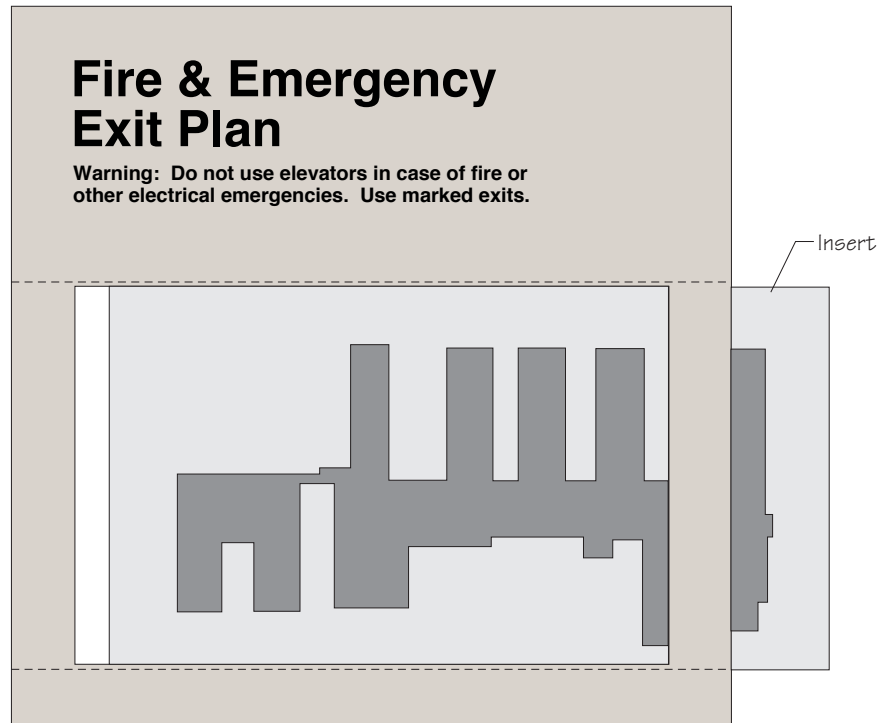
Mounting

Double sided foam tape or silastic adhesive.

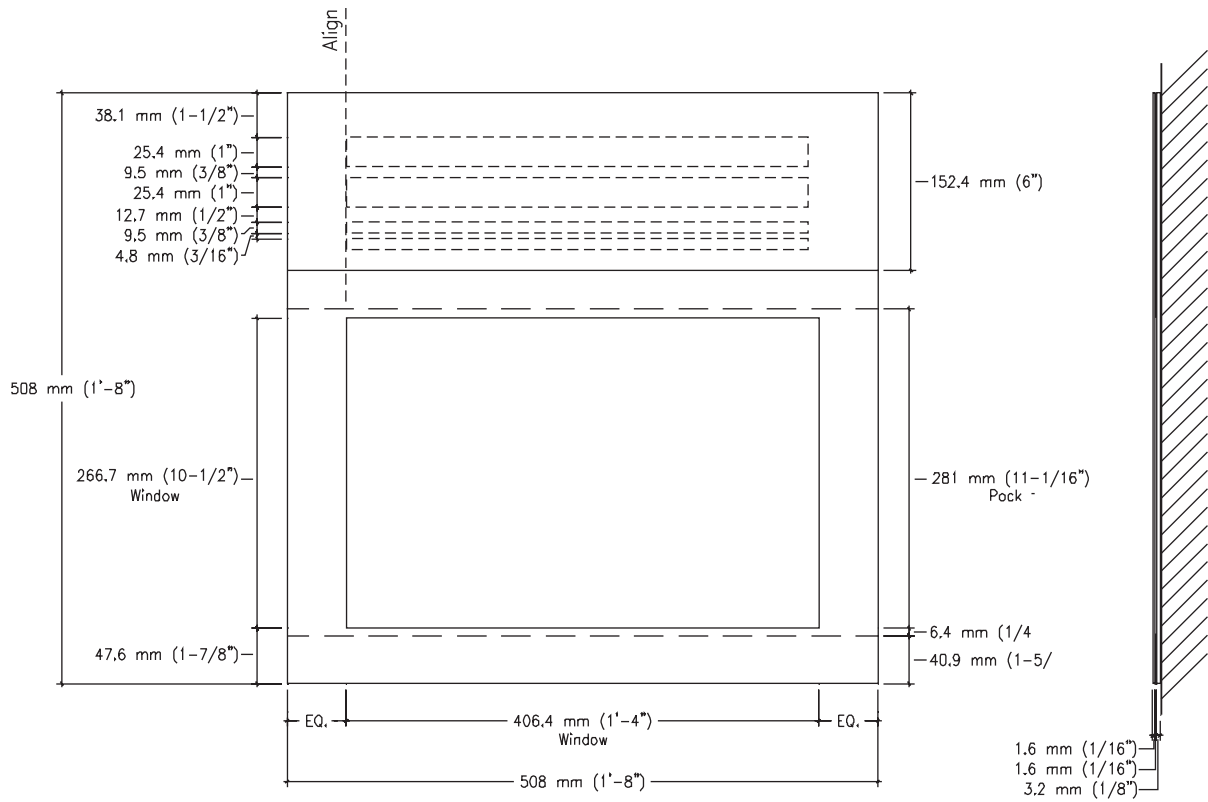
Installation

In wall, 1575 mm (63") to center of sign.

Emergency Exit Plan



Emergency Exit Plan



Emergency Exit Plan

Sign

406 mm H x 406 mm W
(16" H x 16" W)

Description & Use

Evacuation Map/Fire Exit Plan with pocket to accept map insert is to be placed at points of exit and transition in a building. All elevators, nurses stations and adjacent to stairwell doors. Other locations as needed. Evacuation maps (8 1/2" x 14" paper) can be created by the medical center and inserted in to the sign in accord with the evacuation plan relative to the specific location of the sign.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Face: Clear 1.5 mm (1/16") non-glare acrylic with subsurface background color creating a clear window.
Spacer to receive a clear .4 mm (1/64") insert with vinyl letters.
Backing Plaque: Surface painted 6 mm (1/4") acrylic.

Graphic Process

Sign: Silk-screened.
Insert: Printed

Colors

Type: Refer to Color Chart.
Background: Refer to Color Chart

Typography

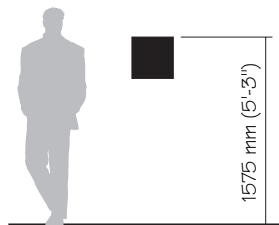
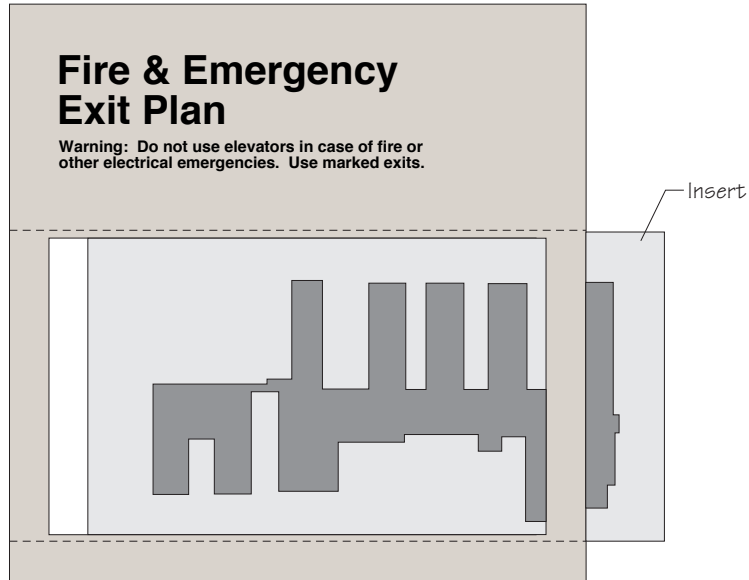
Helvetica Medium

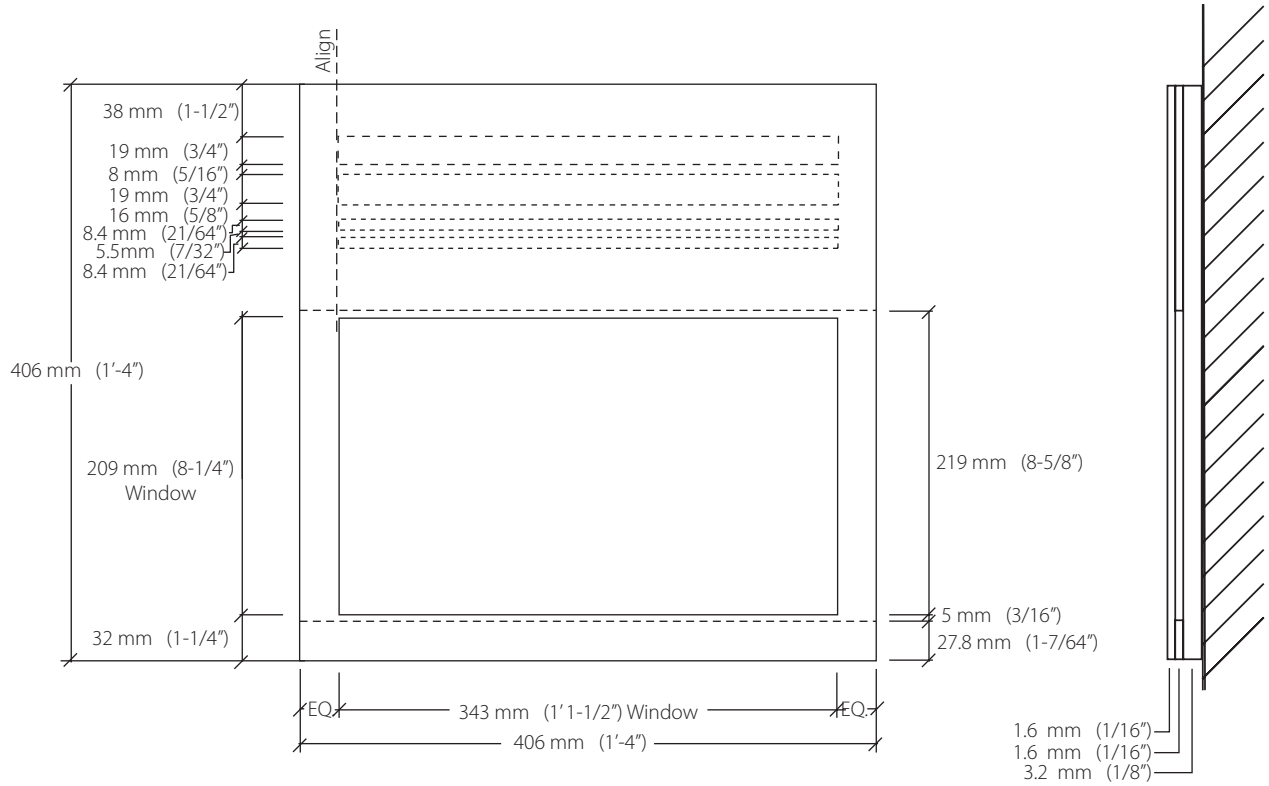
Mounting

Double sided foam tape or silastic adhesive.

Installation

In wall, 1575 mm (63") to center of sign.





Sign

330 mm H x 330 mm W
13" H x 13" W)

Description & Use

Evacuation Map/Fire Exit Plan with pocket to accept map insert is to be placed at points of exit and transition in a building. All elevators, nurses stations and adjacent to stairwell doors. Other locations as needed. Evacuation maps (8 1/2" x 11" paper) can be created by the medical center and inserted in to the sign in accord with the evacuation plan relative to the specific location of the sign.

For Hoptel use. Install on door inside every patient room with map insert to correspond with each location.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Face: Clear 1.5 mm (1/16") non-glare acrylic with subsurface background color creating a clear window.

Spacer to receive a clear .4 mm (1/64") insert with vinyl letters.

Backing Plaque: Surface painted 6 mm (1/4") acrylic.

Graphic Process

Sign: Silk-screened.

Insert: Printed

Colors

Text: Refer to Color Chart.

Background: Refer to Color Chart

Typography

Helvetica Medium

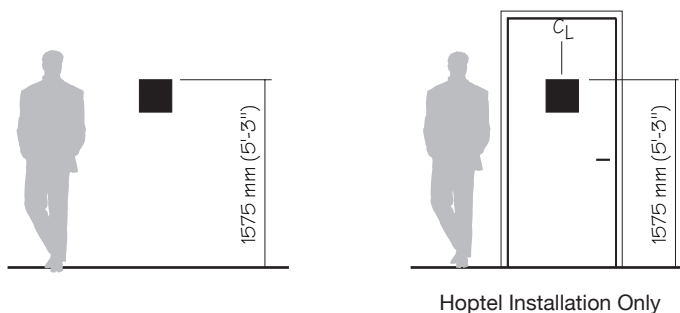
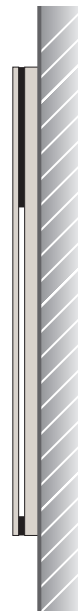
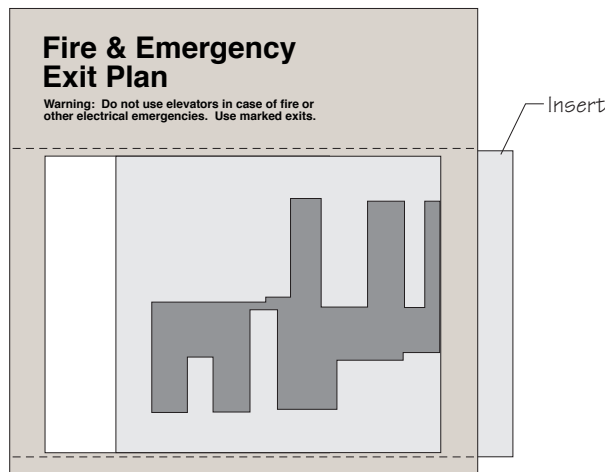
Mounting

Double sided foam tape or silastic adhesive.

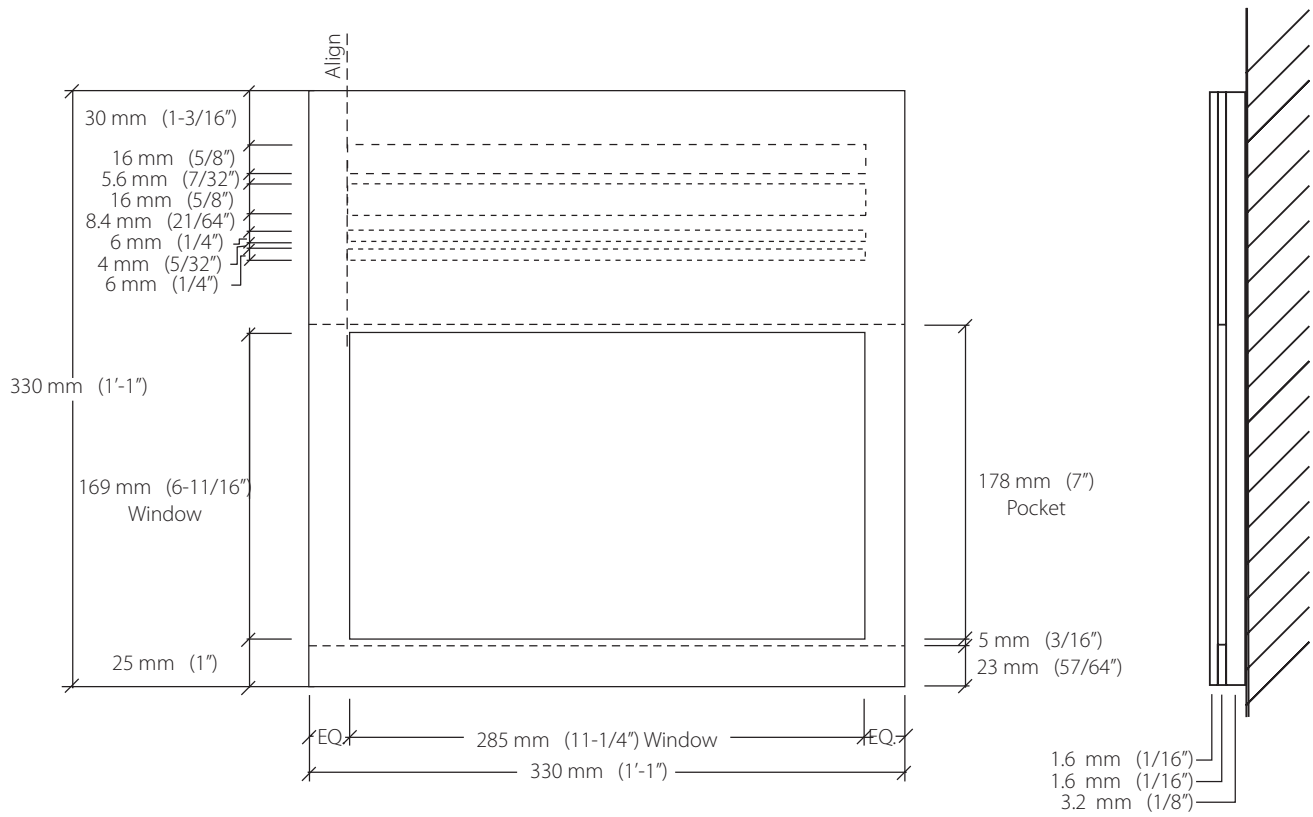
Installation

In wall, 1575 mm (63") to center of sign.

For Hoptel: On back of door inside room, 1575 mm (63") to center of sign.



Hoptel Installation Only



Sign

229 mm H x 229 mm W
(9" H x 9" W)

Description & Use

Fire Equipment Identification Sign
is used to locate and identify
fire equipment cabinets.

Message Configuration

(Refer to layout drawing for
lettering sizes and dimensions)

Sign Components

Acrylic Plaque

Graphic Process

Silk-screened.

Colors

Text & Symbol: White - T1
Background: Red - B3

Typography

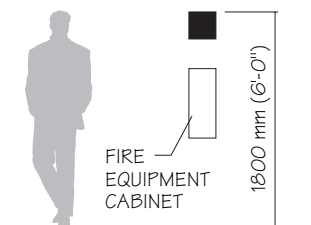
Helvetica Medium

Mounting

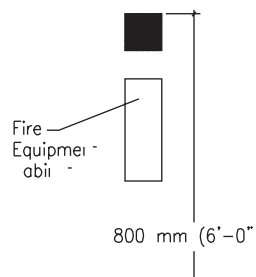
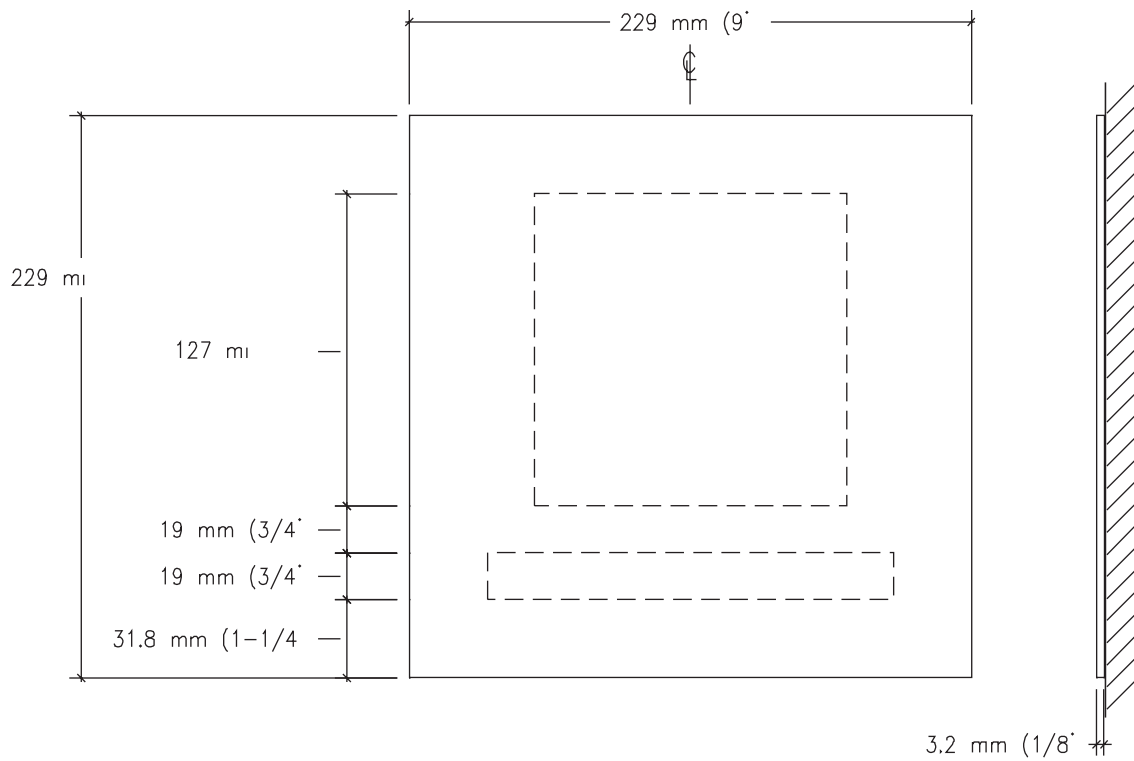
Double sided foam tape or silastic
adhesive.

Installation

In wall, 1575 mm (63") to top of
sign.

Fire Equipment Identification Sign

Fire Equipment Identification Sign



Sign

229 mm H x 229 mm W
(9" H x 9" W)

Description & Use

Fire procedure sign to be installed at elevators, adjacent to stairwell doors, nurse stations, and other locations as needed.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Acrylic Plaque

Graphic Process

Silk-screened.

Colors

Text: Refer to Color Chart.

Background: Refer to Color Chart

Typography

Helvetica Medium

Mounting

Double sided foam tape or silastic adhesive.

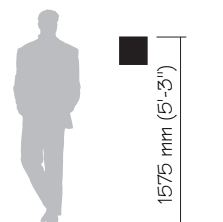
Installation

In wall, 1575 mm (63") to top of sign.

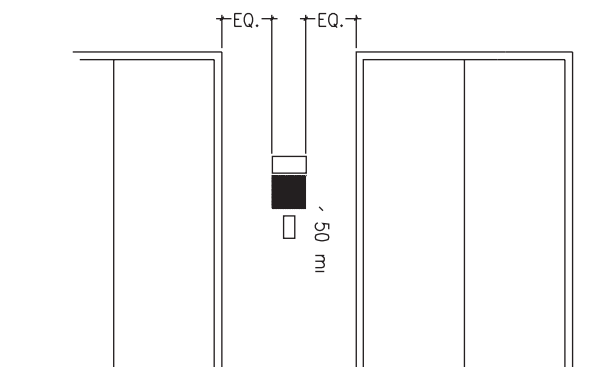
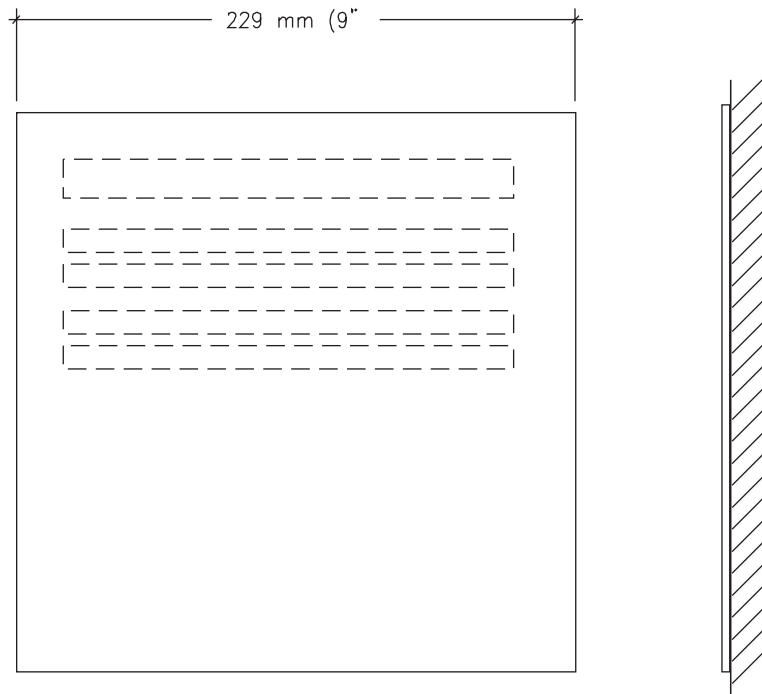
Fire Procedure Sign

IN CASE OF FIRE

1. Rescue patients & visitors from room.
2. Activate fire alarm pull station & contact emergency forces.
3. Close all doors to rooms.
4. Extinguish fire with portable fire extinguisher only if fire is small.



Fire Procedure Sign



Elevator Call Button**Sign**

152 mm H x 229 mm W
(6" H x 9" W)

Description & Use

Elevator Call Button Fire procedure sign to be installed at elevators.
Position above Type IN01.3.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Acrylic Plaque

Graphic Process

Silk-screened

Colors

Text & Symbols: White - T1
Background: Red - B3

Typography

Helvetica Medium

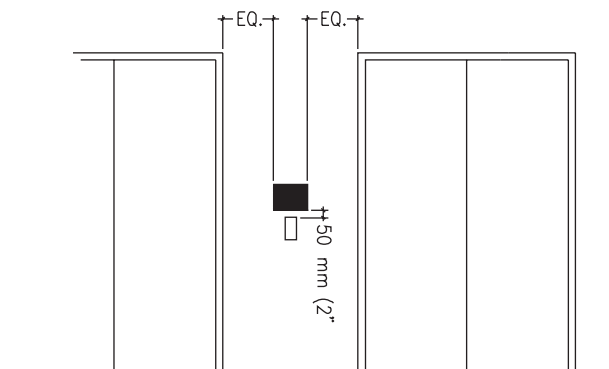
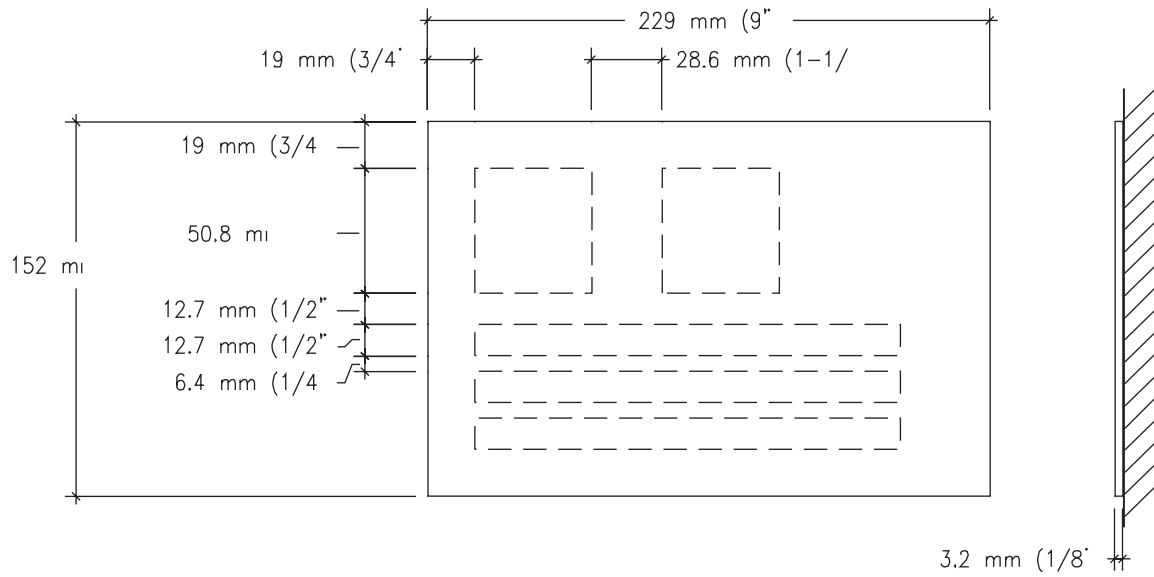
Mounting

Double sided foam tape or silastic adhesive.

Installation

Centered 50mm (2") directly above elevator call button.





Sign

229 mm H x 229 mm W
(9" H x 9" W)

Description & Use

Fire Door Sign is used to identify a fire door. Exception: doors held open by automatic devices.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Acrylic Plaque

Graphic Process

Silk-screened

Colors

Text: White - T1

Background: Red - B3

Typography

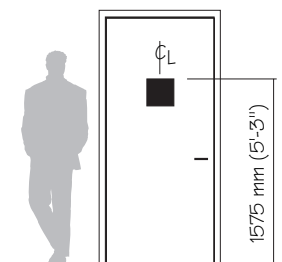
Helvetica Medium

Mounting

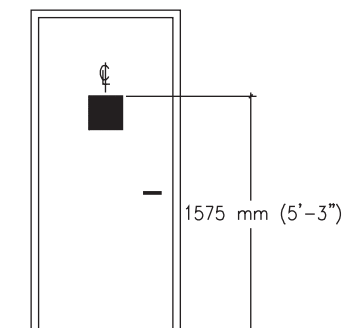
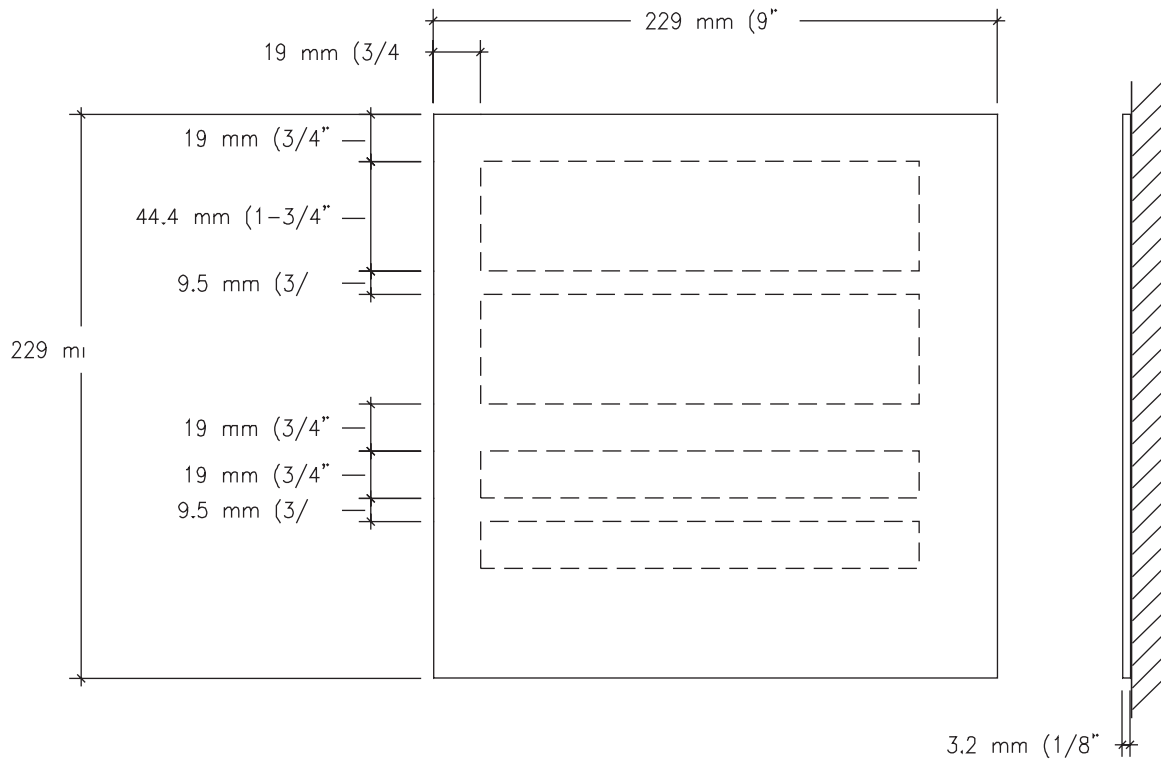
Double sided foam tape or silastic adhesive.

Installation

On door, centered, 1575 mm (63") to top of sign.

Fire Door Sign

Fire Door Sign



Sign

229 mm H x 229 mm W
(9" H x 9" W)

Description & Use

No Exit Sign used to identify a door in a stairwell or other locations, that are not fire exits.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Acrylic Plaque

Graphic Process

Silk-screened

Colors

Text: Refer to Color Chart.

Background: Refer to Color Chart.

Typography

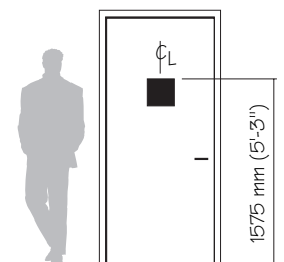
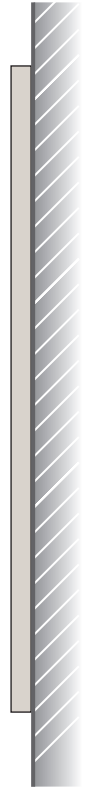
Helvetica Medium

Mounting

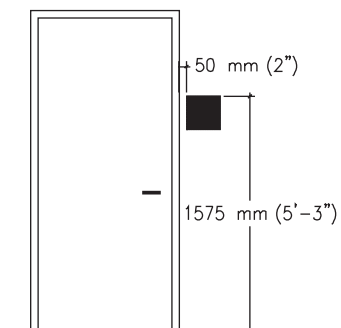
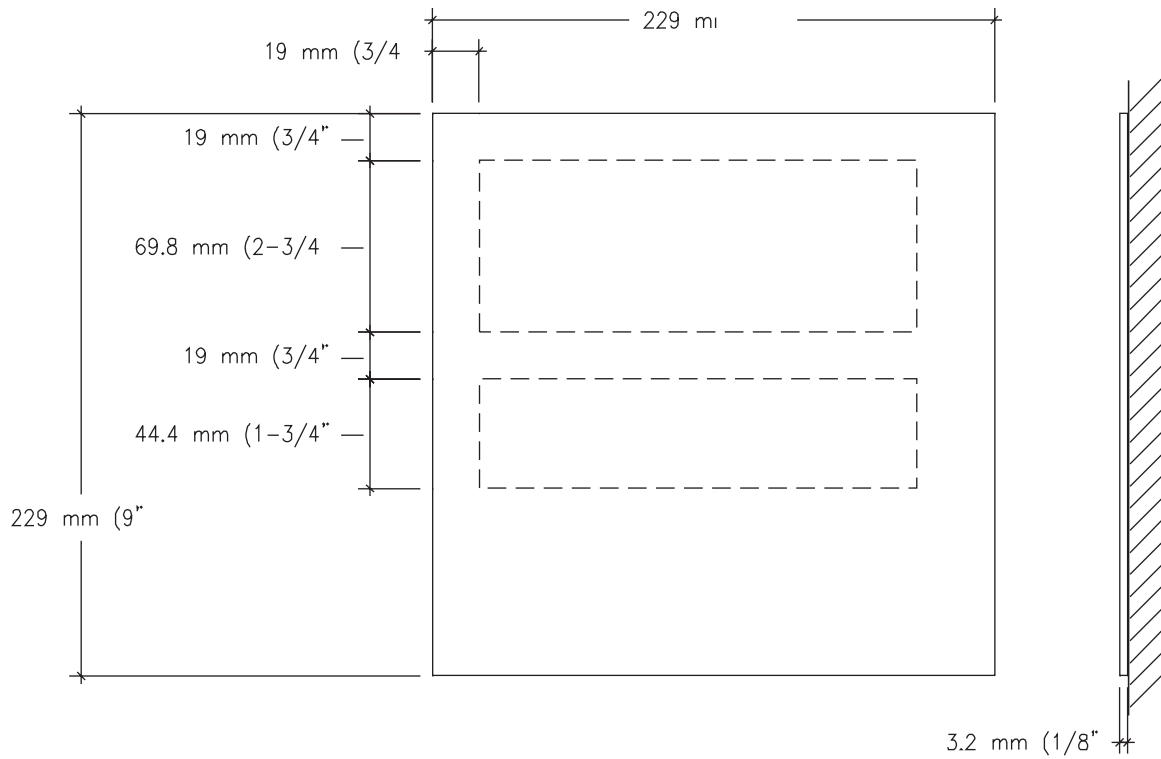
Double sided foam tape or silastic adhesive.

Installation

Centered on door, 1575 mm (63") to top of sign



No Exit Sign



Exit Sign

Size

IN-01.07.01
229 mm x 559 mm
(9" x 22")

IN-01.07.02
229 mm x 559 mm
(9" x 22")

IN-01.07.03
229 mm x 559 mm
(9" x 22")

IN-01.07.04
229 mm x 712 mm
(9" x 28")

Description & Use

Non illuminated exit sign used to identify exit or direction to exit.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)
Principle stroke of letters not less than 3/4" wide. Each letter must have a width of no less than 2" except the letter "i". Minimum spacing between letters no less than 3/8".

Sign Components

Acrylic Plaque

Graphic Process

Silk-screened.

Colors

Text: Refer to Color Chart.
Background: Refer to Color Chart.

Typography

Helvetica Condensed Medium

Mounting

Double sided foam tape or silastic adhesive.

Installation

Center on soffit area directly above door frame.



IN-01.07.01



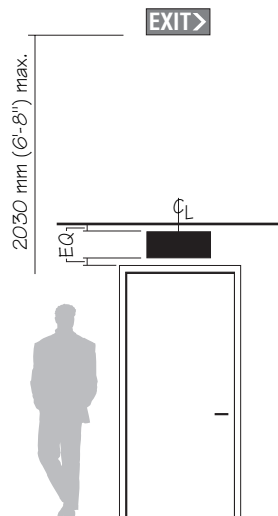
IN-01.07.02



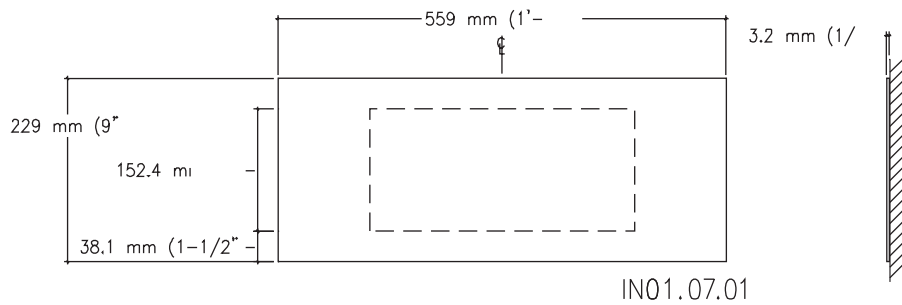
IN-01.07.03



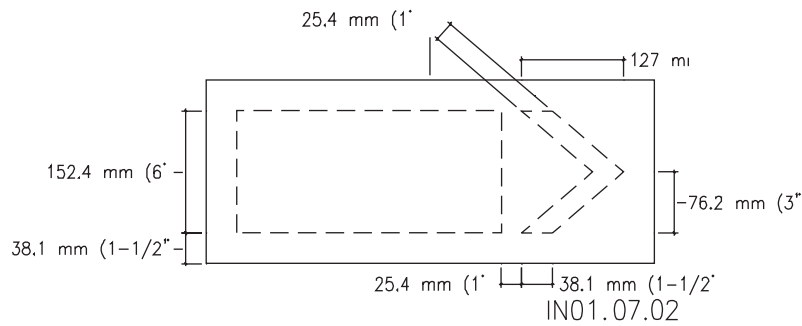
IN-01.07.04



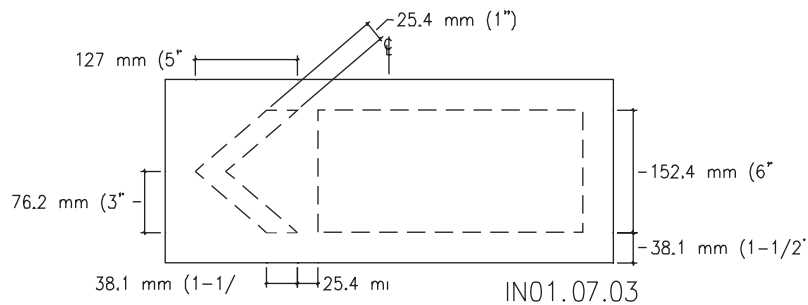
Exit Sign



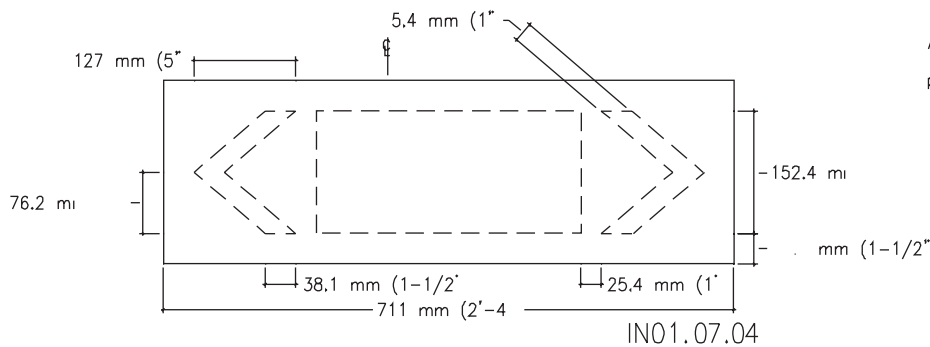
IN01.07.01



IN01.07.02

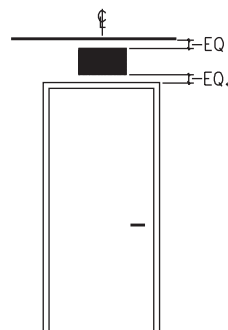


IN01.07.03



IN01.07.04

ARROW: Right and/or left arrow positioning relative to sign



Automatic Fire Door Sign - Hinged**Size**

229 mm H x 229 mm W
(9" H x 9" W)

Description & Use

Prohibit/Do Not Block information to be communicated at hinged fire doors held open by automatic devices.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Acrylic Plaque

Graphic Process

Silk-screened.

Colors

Text: Refer to Color Chart.
Background: Refer to Color Chart.

Typography

Helvetica Medium

Mounting

Double sided foam tape or silastic adhesive.

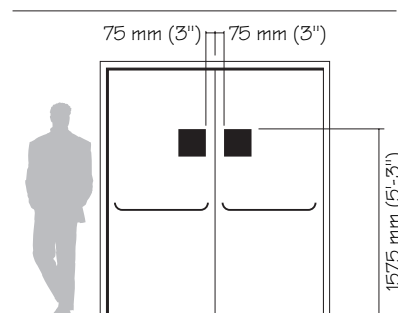
Installation

On door, 1575 mm (63") to top of sign and 75 mm (3") over from door edge.

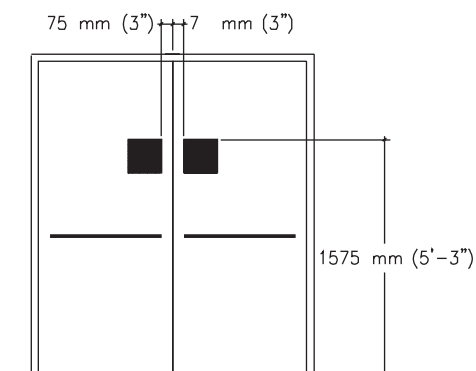
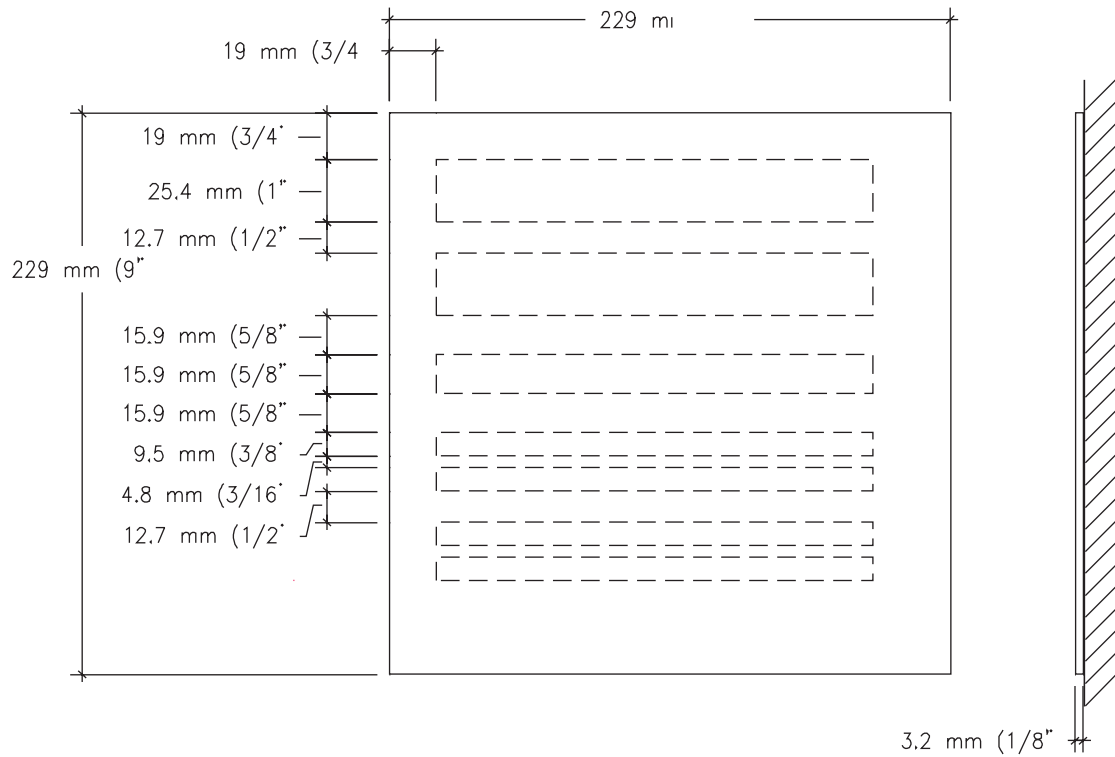
Automatic Fire Door DO NOT BLOCK

This fire door is arranged to swing closed automatically.

Do not block the doorway or place any article in contact with the door.



Automatic Fire Door (Hinged) Sign



Automatic Fire Door Sign - Roll Up**Size**

229 mm H x 229 mm W
(9" H x 9" W)

Description & Use

Prohibit/Do Not Block information to be communicated at roll down fire doors held open by automatic devices.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Acrylic Plaque

Graphic Process

Silk-screened.

Colors

Text: Refer to Color Chart.

Background: Refer to Color Chart.

Typography

Helvetica Medium

Mounting

Double sided foam tape or silastic adhesive.

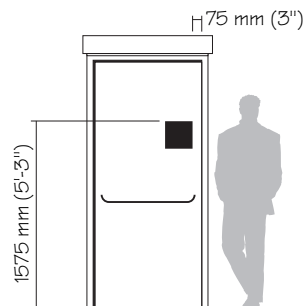
Installation

On wall, adjacent to door, 1575 mm (63") to top of sign.

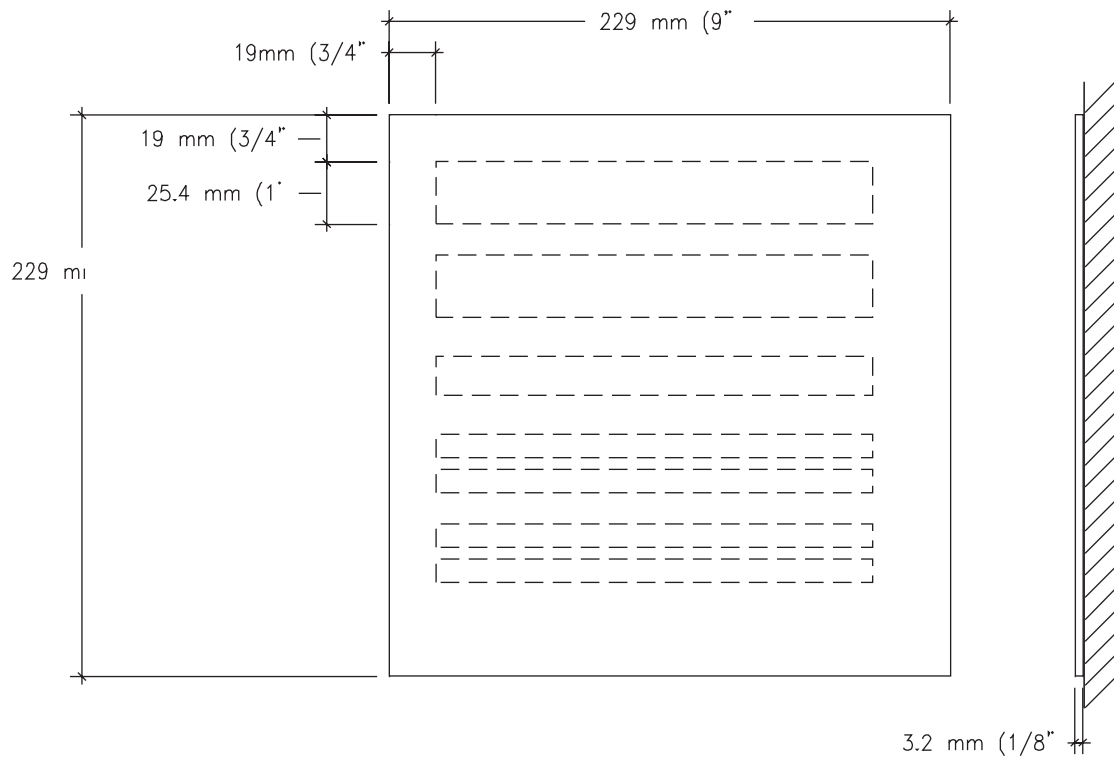
Automatic Fire Door DO NOT BLOCK

**This fire door is arranged to
drop automatically.**

**Do not block this area or
place any article under the
door.**



Automatic Fire Door (Roll Up)



—

Stair Identification Sign

Size

229 mm H x 229 mm W
(9" H x 9" W)

Description & Use

To identify stairwell doors that are fire exits.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Etched sign face laminated to acrylic backing plaque.

Graphic Process

Tactile text with accompanying Braille.

Colors

Text: Refer to Color Chart.
Background: Refer to Color Chart.

Typography

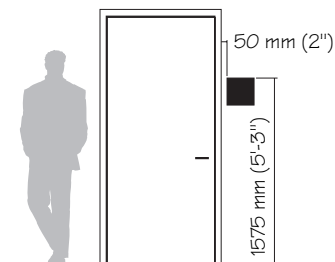
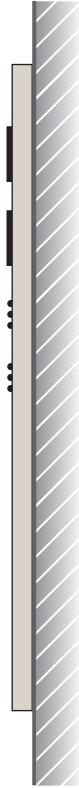
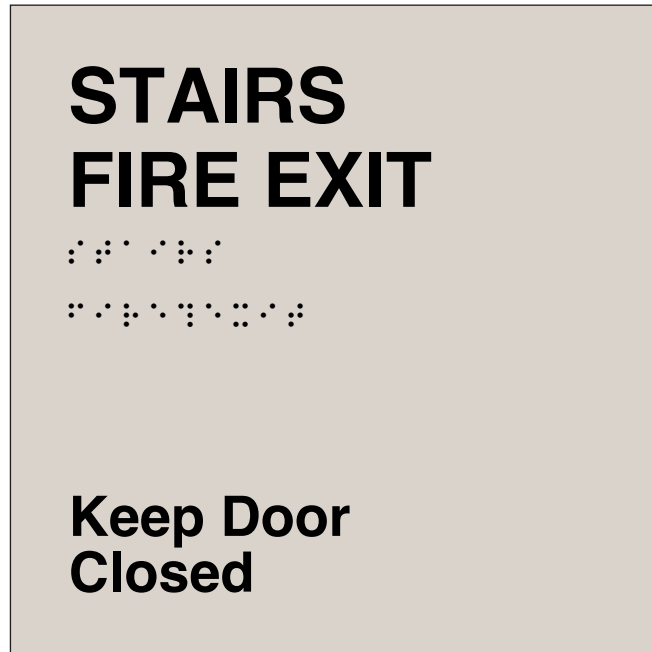
Helvetica Medium
Grade 2 Braille

Mounting

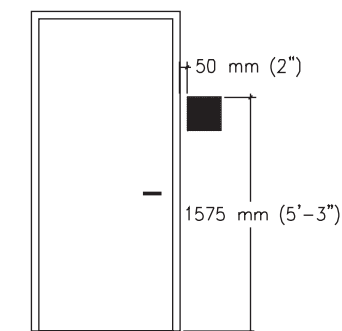
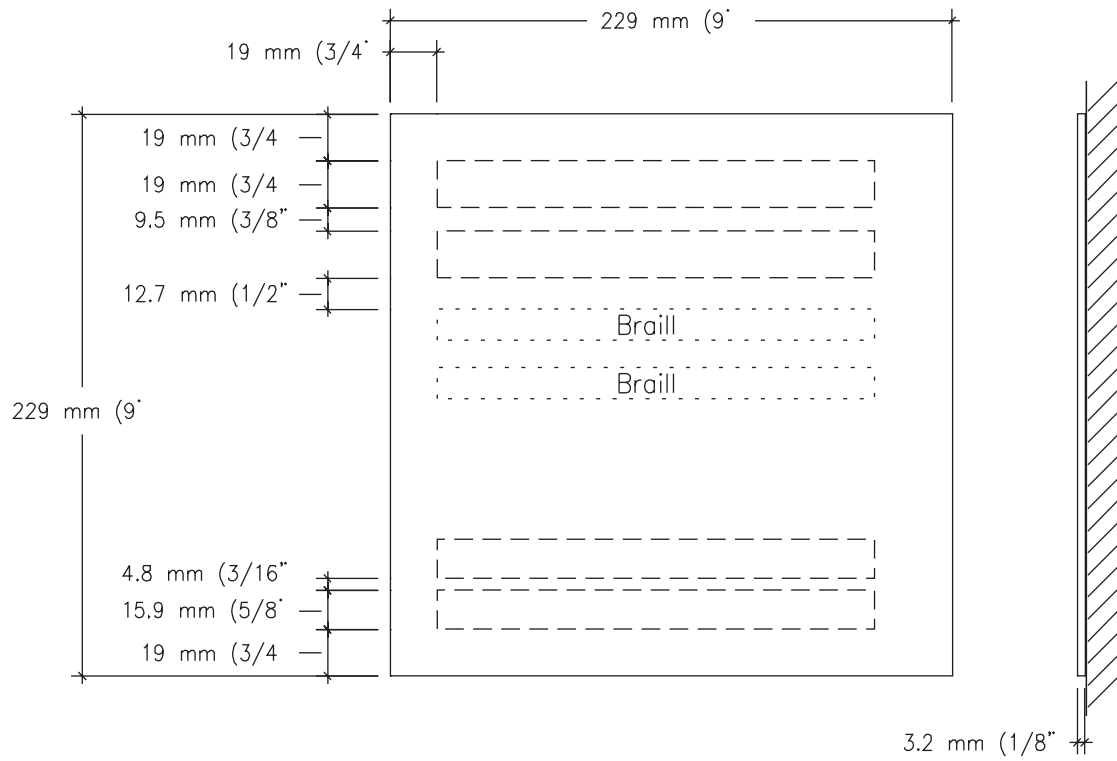
Double sided foam tape or silastic adhesive.

Installation

Knob side of door, 1575 mm (63") to top of sign and 50 mm (2") over from door frame.



Stair Identification Sign



Size

457 mm H x 457 mm W
(18" H x 18" W)

Description & Use

Stairwell, floor level and egress information. Sign is located within the stair enclosure at each floor landing and must be readily visible when stair door is in open or closed position.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Etched sign face laminated to acrylic backing plaque.

Graphic Process

Silk-screened text. Dimensional floor number. Tactile text with accompanying Braille.

Colors

Text: Refer to Color Chart.
Background: Refer to Color Chart.

Typography

Helvetica Medium
Grade 2 Braille

Mounting

Double sided foam tape or silastic adhesive.

Installation

Knob side of door, 1500 mm (60") to bottom of sign and 50 mm (2") over from door frame.

Stairwell Identification Sign

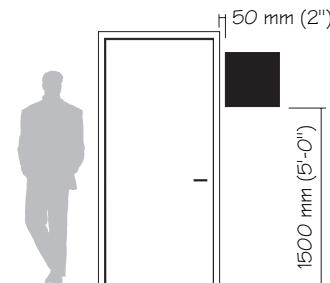
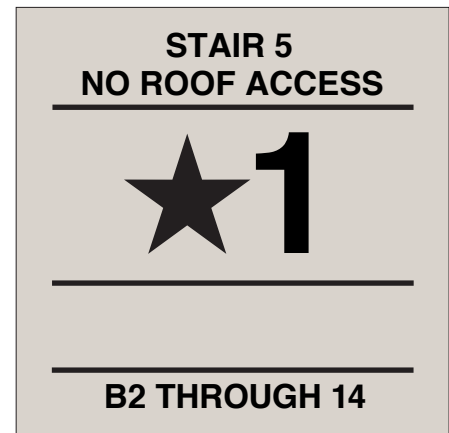
Message Layout A



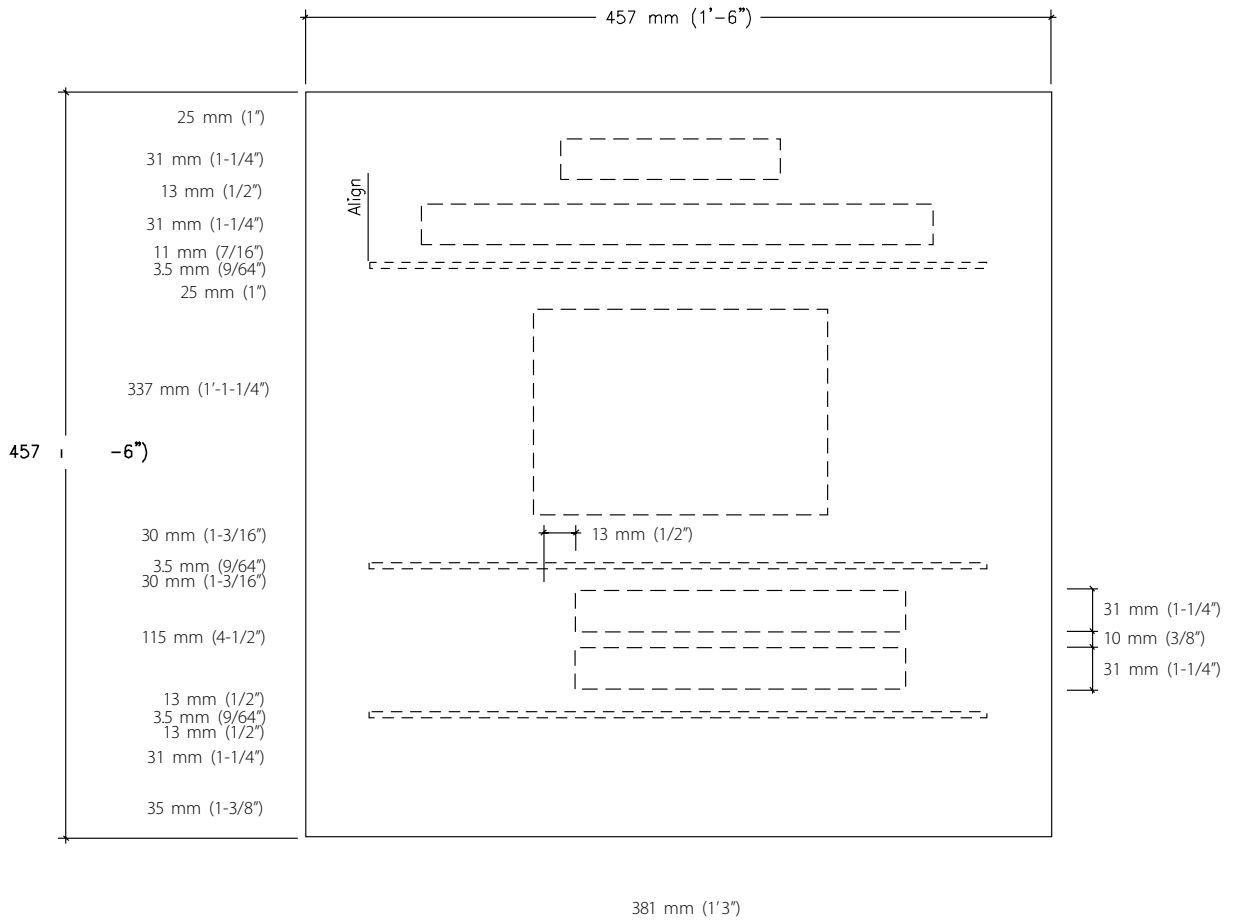
Message Layout B



Message Layout C



Stairwell Identification Sign



Size

152 mm H x 229 mm W
(6" H x 9" W)

Description & Use

Handicapped evacuation assistance directional sign indicating area of refuge for evacuation assistance.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)
Position arrow to communicate direction in relation to the placement of the sign in the building.

Sign Components

Etched sign face laminated to acrylic backing plaque.

Graphic Process

Tactile text with accompanying Braille.

Colors

Text: Refer to Color Chart.
Background: Refer to Color Chart.

Typography

Helvetica Medium
Grade 2 Braille

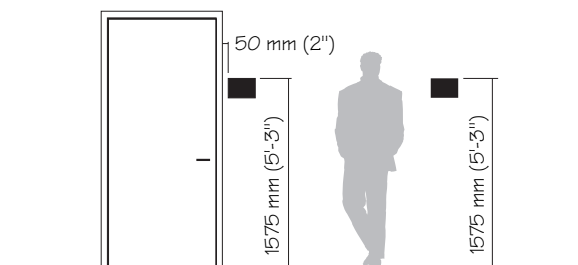
Mounting

Double sided foam tape or silastic adhesive.

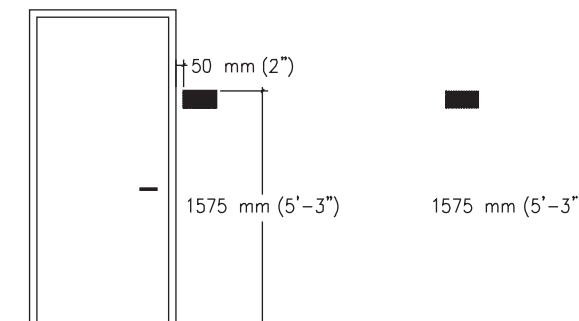
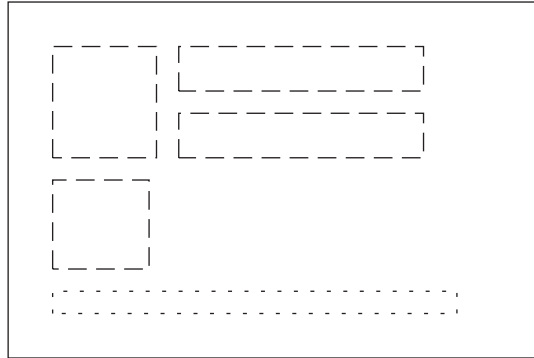
Installation

Knob side of door, 1575 mm (63") to top of sign and 50 mm (2") over from door frame or on wall
1575 mm (63") to top of sign.

Area of Refuge (Evacuation Assistance)



—



Size

229 mm H x 381 mm W
(9" H x 15" W)

Description & Use

Push Alarm Identification Sign is an instructional sign for push alarmed doors.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Acrylic Plaque

Graphic Process

Silk-screened.

Colors

Text: Refer to Color Chart.
Background: Refer to Color Chart.

Typography

Helvetica Medium

Mounting

Double sided foam tape or silastic adhesive.

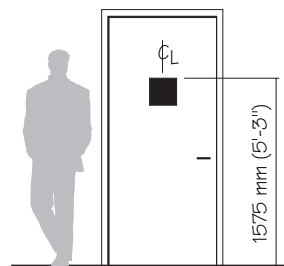
Installation

Centered on door, 1575 mm (63") to top of sign.

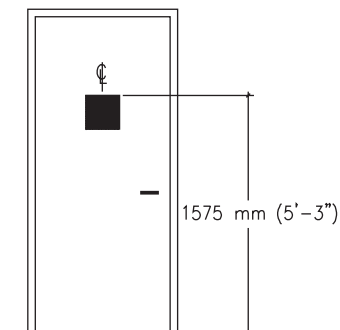
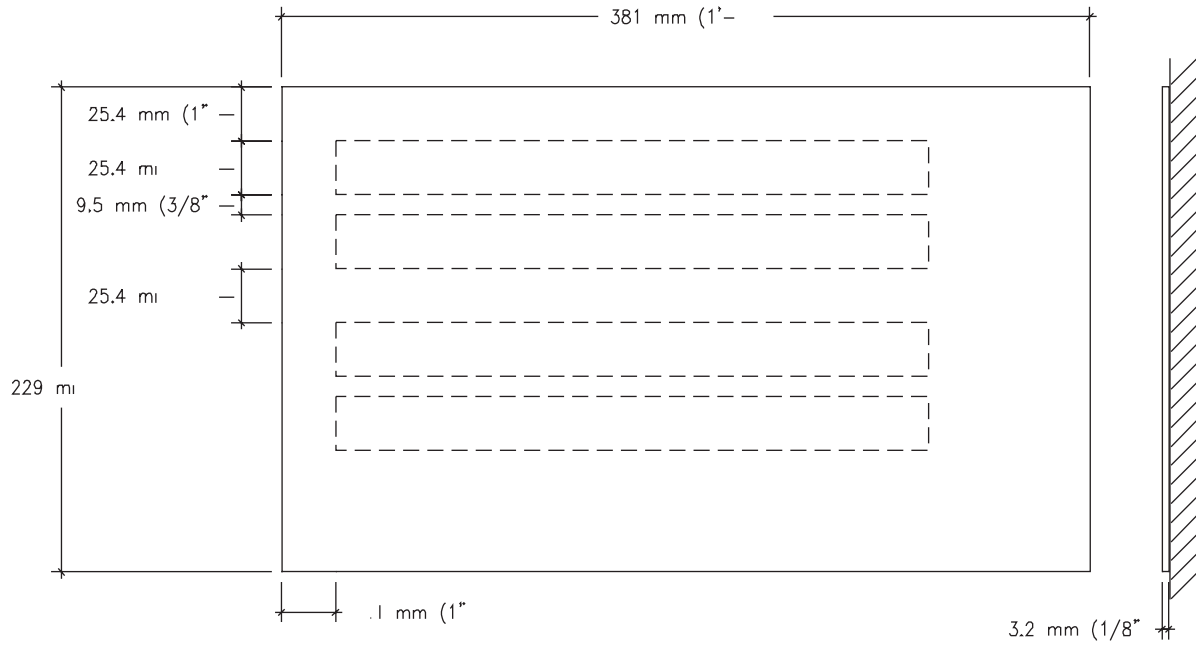
Push Alarm Identification Sign

**PUSH UNTIL
ALARM SOUNDS**

**DOOR CAN BE
OPENED IN 15
SECONDS**



Push Alarm Identification Sign



Open Door Fire Safety Sign**Size**

152 mm H x 308 mm W
(6" H x 20" W)

Description & Use

Open Door Fire Safety Sign is used to identify that a particular door is a fire safety door and is to remain open at certain times.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Acrylic Plaque

Graphic Process

Silk-screened.

Colors

Text: Refer to Color Chart.

Background: Refer to Color Chart.

Typography

Helvetica Medium

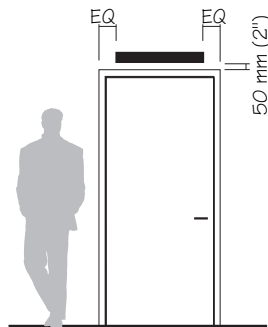
Mounting

Double sided foam tape or silastic adhesive.

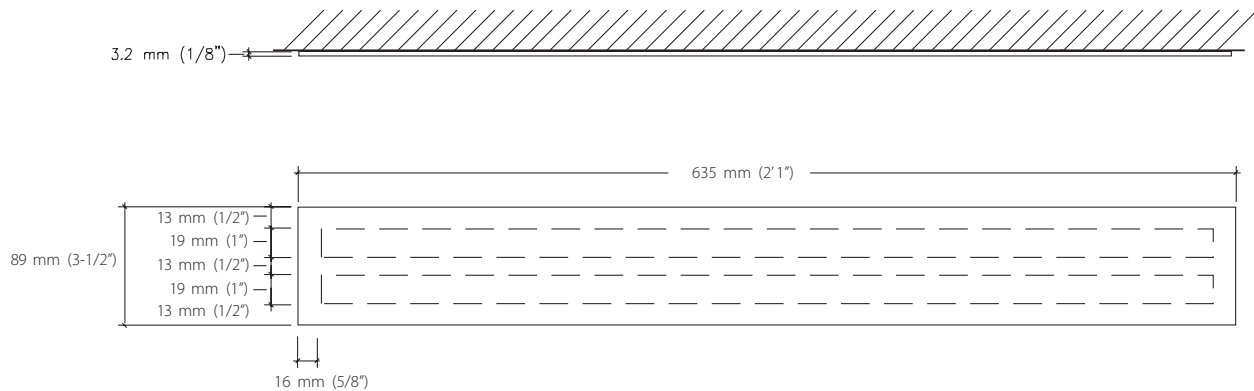
Installation

Centered above door and 50 mm (2") above door frame.

**THIS DOOR TO REMAIN UNLOCKED
WHEN THE BUILDING IS OCCUPIED**



Open Door Fire Safety Sign



Hazardous Material Information Sign

Size

305 mm H x 305 mm W
(12" H x 12" W)

Description & Use

Hazardous Materials Information Sign used to easily identify specific hazards within room, storage cabinet or area.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)
Numbers shown on this drawing are for illustration purposes only. Provide correct numbers, text and colors to correctly identify the hazardous materials within a room. Refer to NFPA (National Fire Protection Association) or material data sheet relating to materials for more information regarding message.

- A Identifies Specific Hazard
- B Identifies Health Hazard
- C Identifies Fire Hazard
- D Identifies Reactivity

Sign Components

Acrylic Plaque

Graphic Process

Silk-screened.

Colors

Text: Black - T4

Background:

- A White
- B Safety Blue (OSHA)
- C Safety Red (OSHA)
- D Safety Yellow (OSHA)

Typography

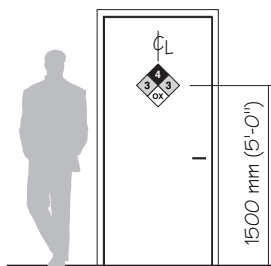
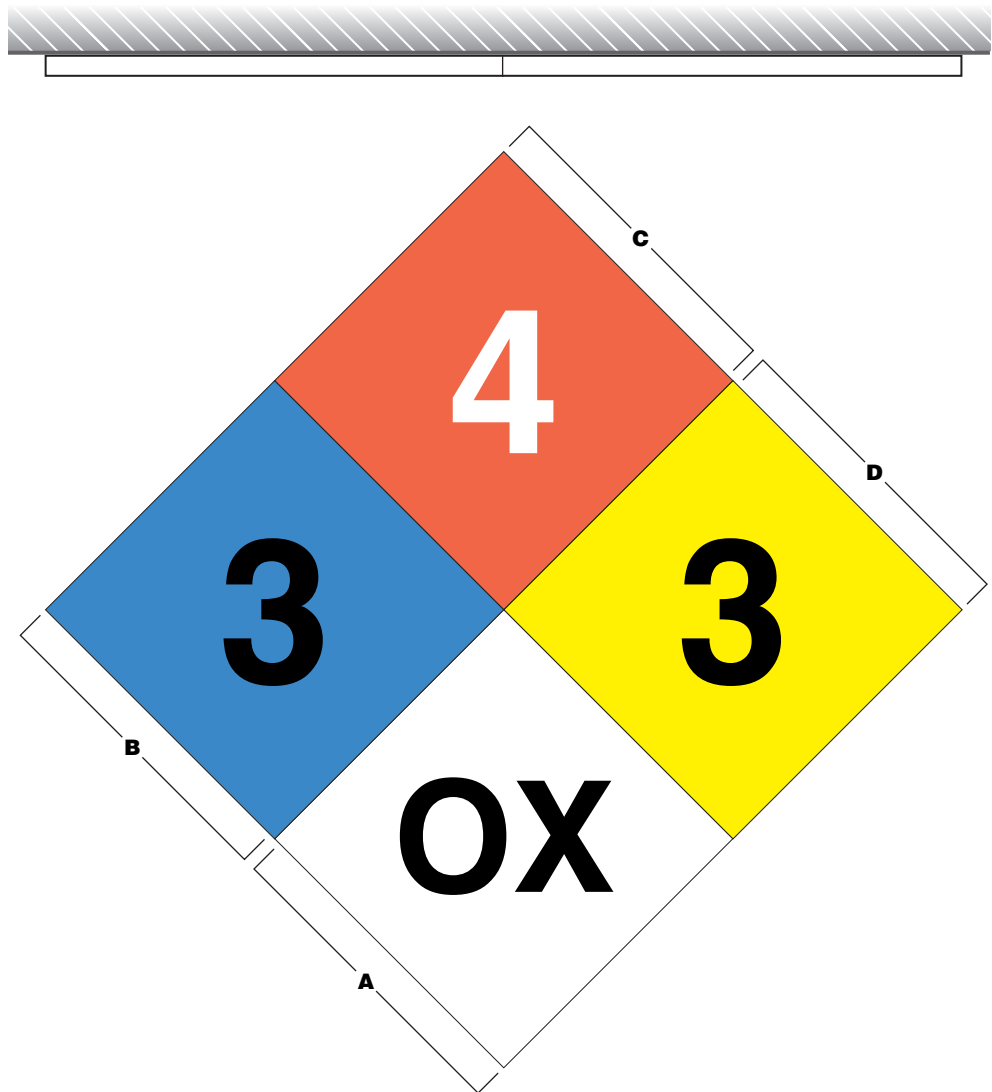
Helvetica Medium

Mounting

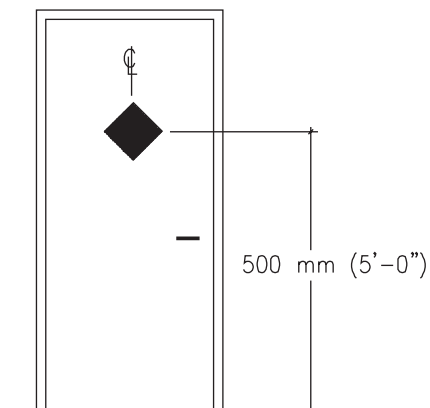
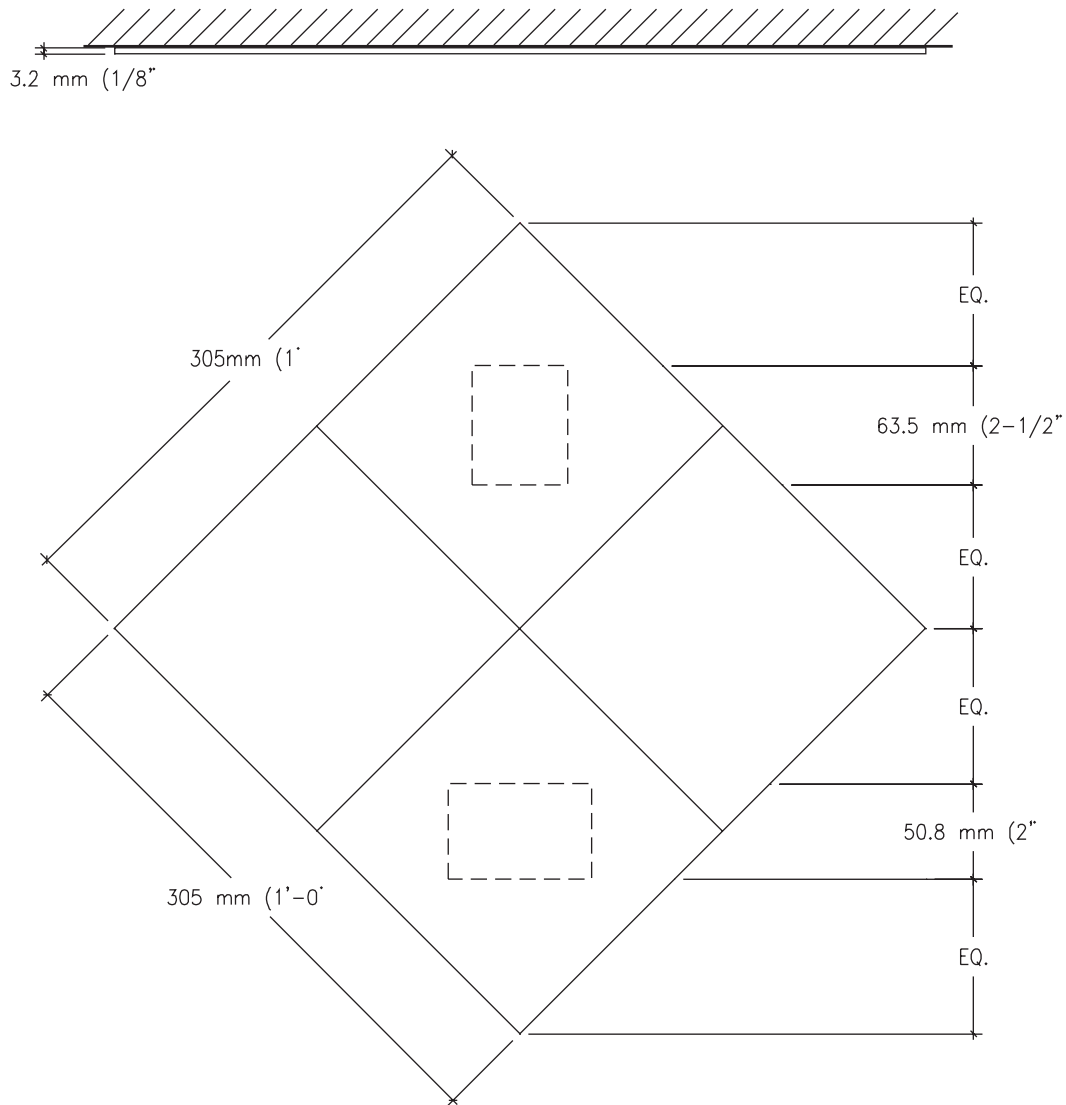
Double sided foam tape or silastic adhesive.

Installation

Centered on door and 1500 mm (60") to center of sign.



Material Fire Identification Sign



Size

229 mm H x 229 mm W
(9" H x 9" W)

Description & Use

Caution information regarding oxygen in use. Sign is to be installed on all doors to rooms that contain oxygen in use.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Acrylic Plaque

Graphic Process

Silk-screened.

Colors

Text: Refer to Color Chart.
Background: Refer to Color Chart.

Typography

Helvetica Medium

Mounting

Double sided foam tape or silastic adhesive.

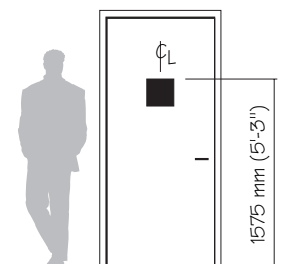
Installation

Centered on door, 1575 mm (63") to top of sign.

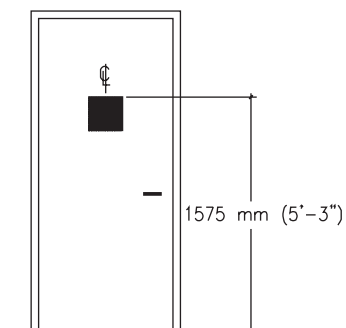
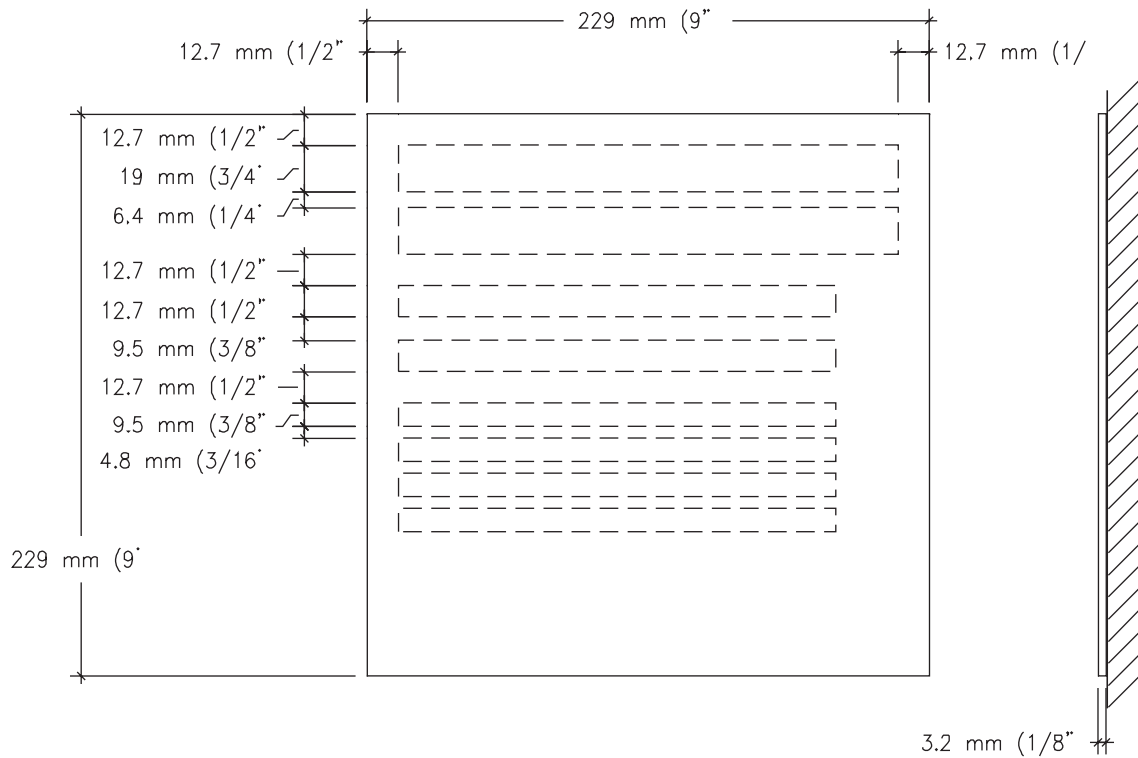
Oxygen In Use Warning Sign

**CAUTION
OXYGEN IN USE
NO SMOKING
NO OPEN FLAMES**

**Any material that can burn in
air will burn more rapidly in the
presence of oxygen. No
electrical equipment is allowed
within an oxygen enclosure or
within 5 ft. (1.5 m) of it.**



Oxygen In Use Warning Sign



Size

229 mm H x 229 mm W
(9" H x 9" W)

Description & Use

Caution information regarding gases in use. Sign is to be installed on all doors to rooms that contain the listed gases. Adjust the listing of gases to reflect the actual gases being used in the laboratory.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Acrylic Plaque

Graphic Process

Silk-screened.

Colors

Text: Refer to Color Chart.
Background: Refer to Color Chart.

Typography

Helvetica Medium

Mounting

Double sided foam tape or silastic adhesive.

Installation

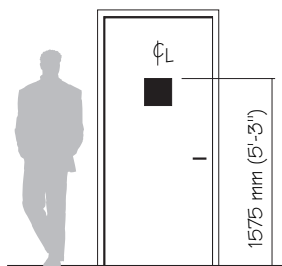
Centered on door, 1575 mm (63") to top of sign.

Compressed Gas Warning Sign

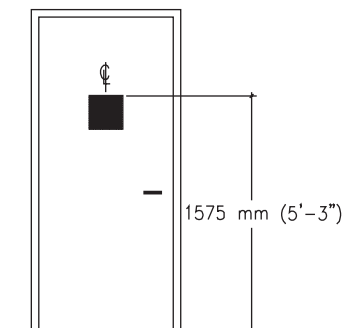
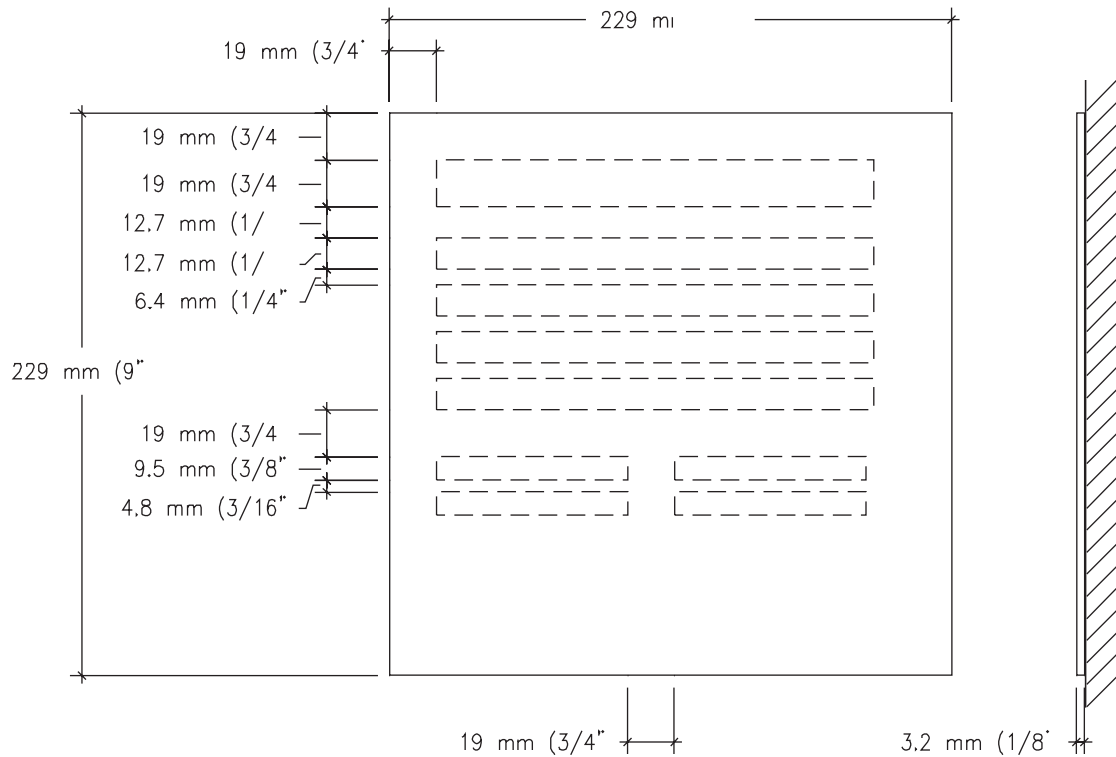
Warning
The following gases
in compressed
cylinders are present
in this laboratory:

Acetylene
Nitrogen
Argon

Helium
Nitric Oxide
Hydrogen



Compressed Gas Warning Sign



Nonflammable Anesthesia Restriction Sign

Size

229 mm H x 229 mm W
(9" H x 9" W)

Description & Use

Caution information regarding anesthetic agents in use. Sign is to be installed on the doors to all operating rooms.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Acrylic Plaque

Graphic Process

Silk-screened.

Colors

Text: Refer to Color Chart.

Background: Refer to Color Chart.

Typography

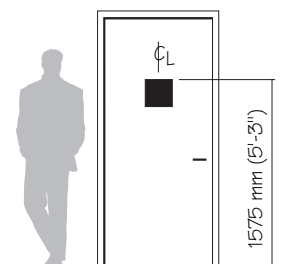
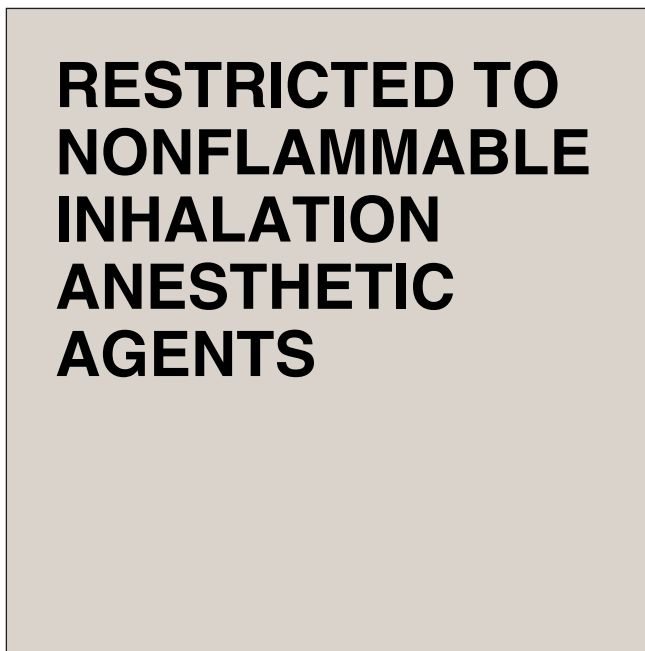
Helvetica Medium

Mounting

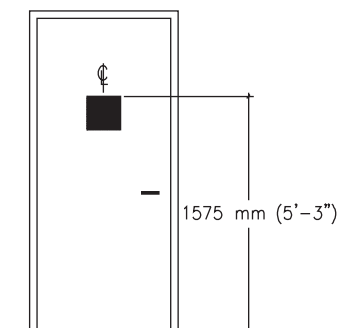
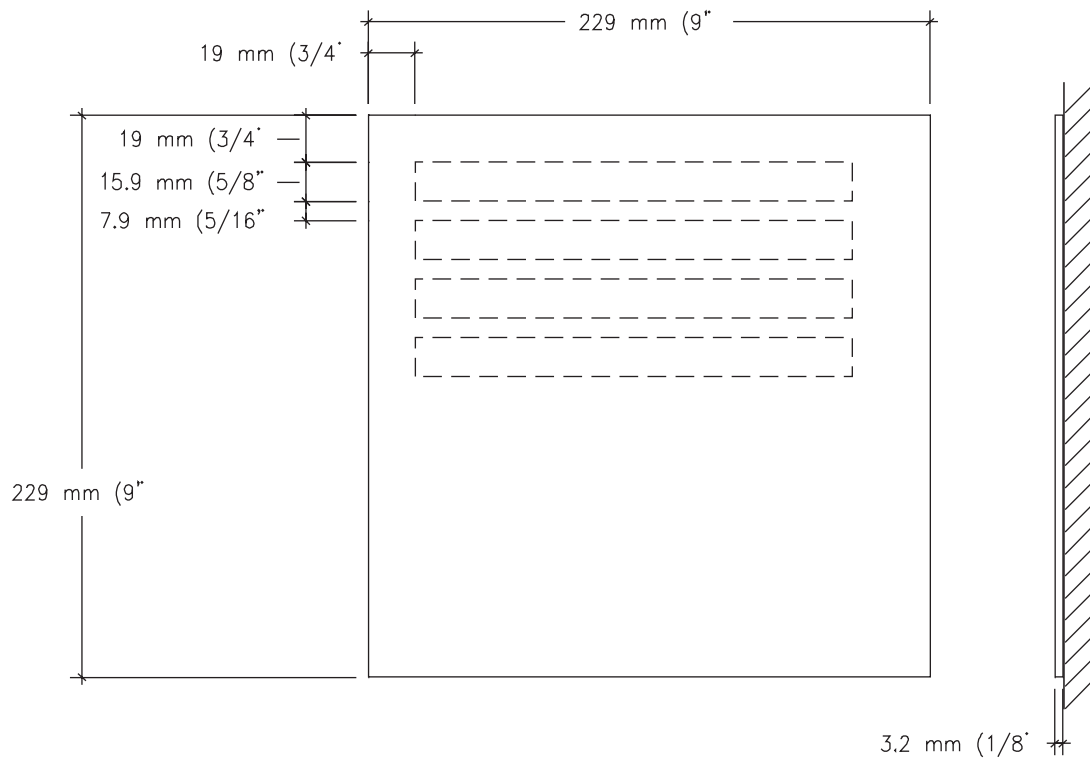
Double sided foam tape or silastic adhesive.

Installation

Centered on door, 1575 mm (63") to top of sign.



Nonflammable Anesthesia Restriction Sign



Radioactive Material Warning Sign**Size**

229 mm H x 229 mm W
(9" H x 9" W)

Description & Use

Caution information regarding radioactive material. Sign is to be installed on the doors to all rooms where radioactive material are in use or stored.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Acrylic Plaque

Graphic Process

Silk-screened.

Colors

Text & Symbol: Purple - T7
Background: Yellow - B8

Typography

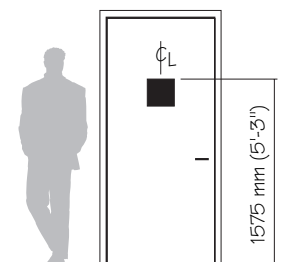
Helvetica Medium

Mounting

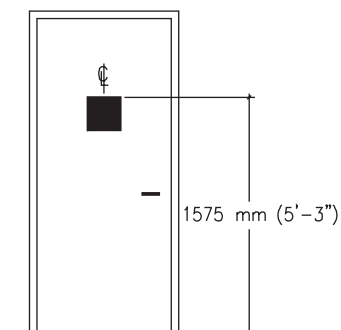
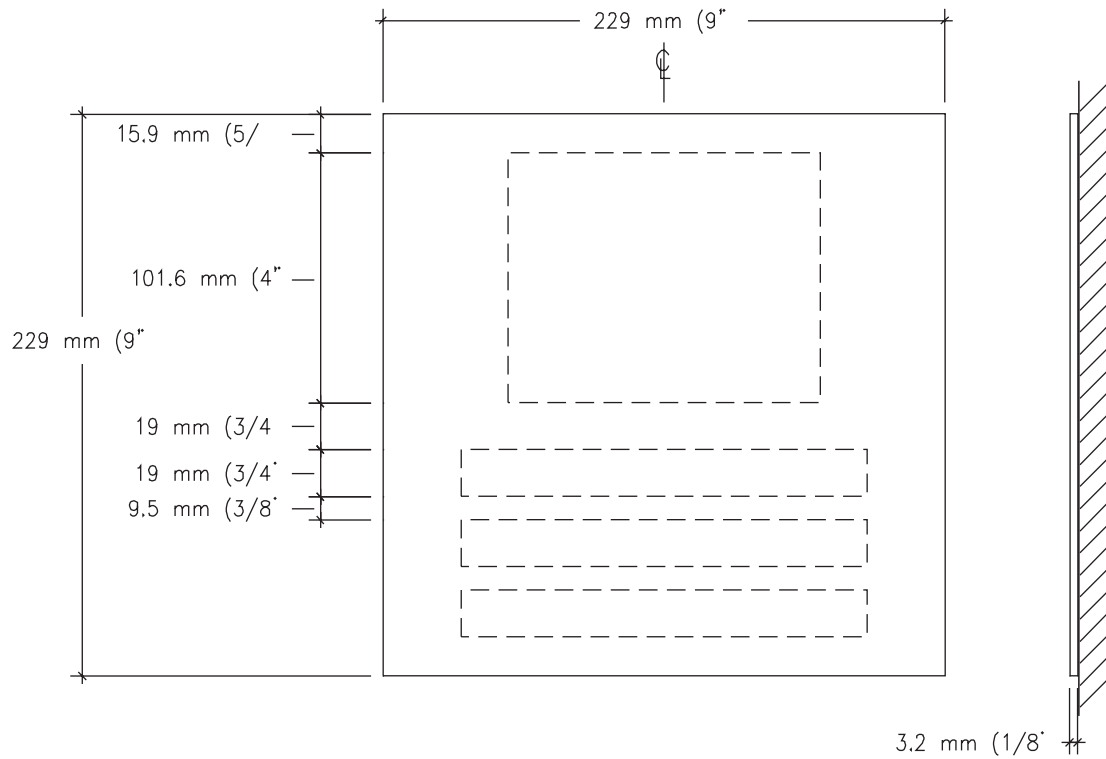
Double sided foam tape or silastic adhesive.

Installation

Centered on door, 1575 mm (63") to top of sign.



Radioactive Material Warning Sign



Radioactive Area Warning Sign

Size

229 mm H x 229 mm W
(9" H x 9" W)

Description & Use

Caution information regarding area with radioactive material. Sign is to be installed in areas where radioactive material are in use or stored.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Acrylic Plaque

Graphic Process

Silk-screened.

Colors

Text & Symbol: Purple - T7
Background: Yellow - B8

Typography

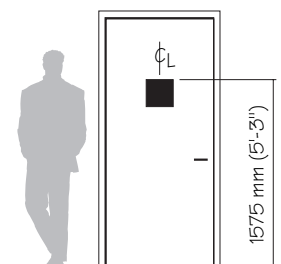
Helvetica Medium

Mounting

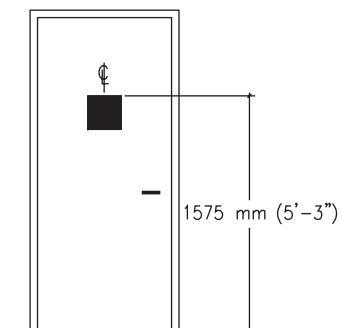
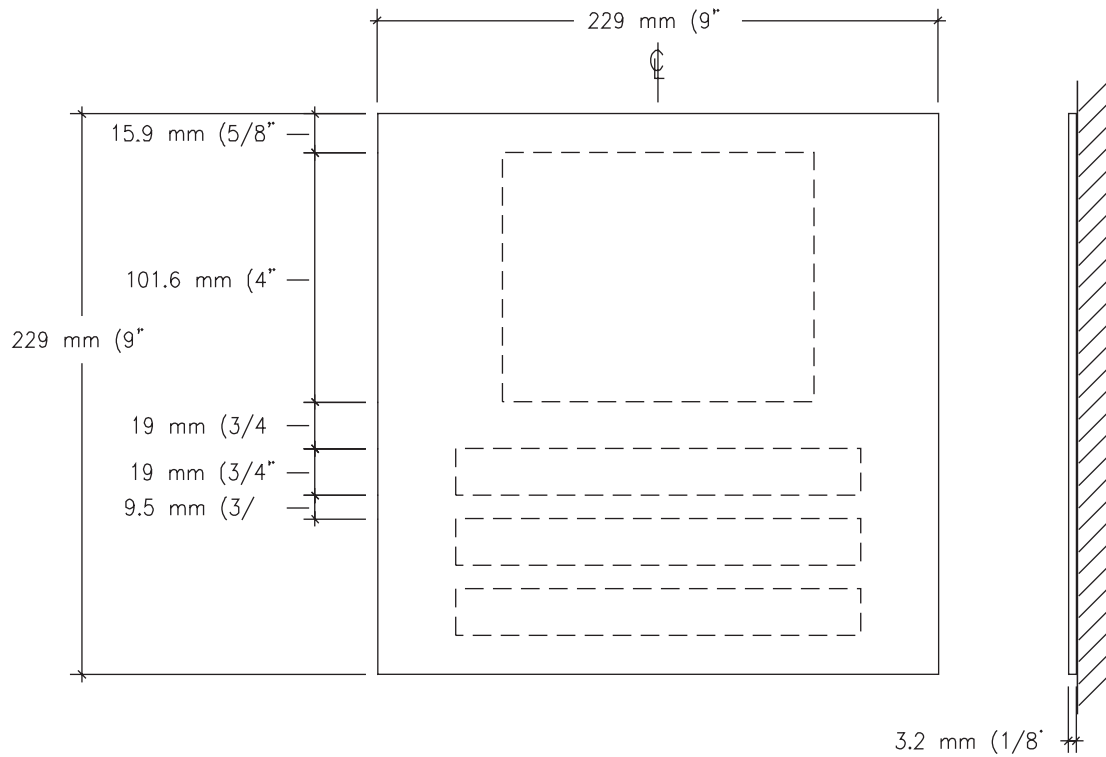
Double sided foam tape or silastic adhesive.

Installation

Centered on door, 1575 mm (63") to top of sign.



Radioactive Area Warning Sign



Size

229 mm H x 229 mm W
(9" H x 9" W)

Description & Use

Caution information regarding high electrical voltage. Sign is to be installed on the doors to all rooms where there is high voltage.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Acrylic Plaque

Graphic Process

Silk-screened.

Colors

Text & Symbol: Black - T4
Background: Yellow - B8

Typography

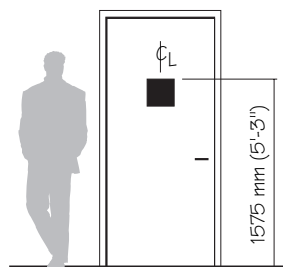
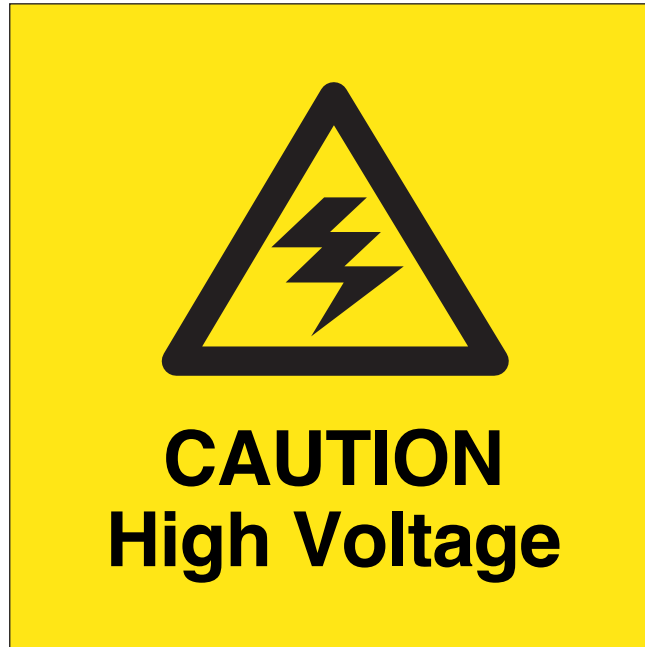
Helvetica Medium

Mounting

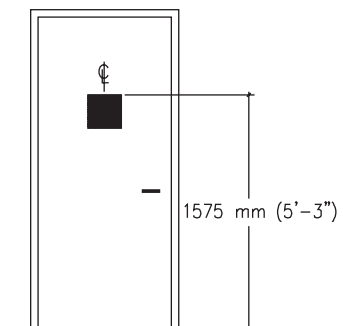
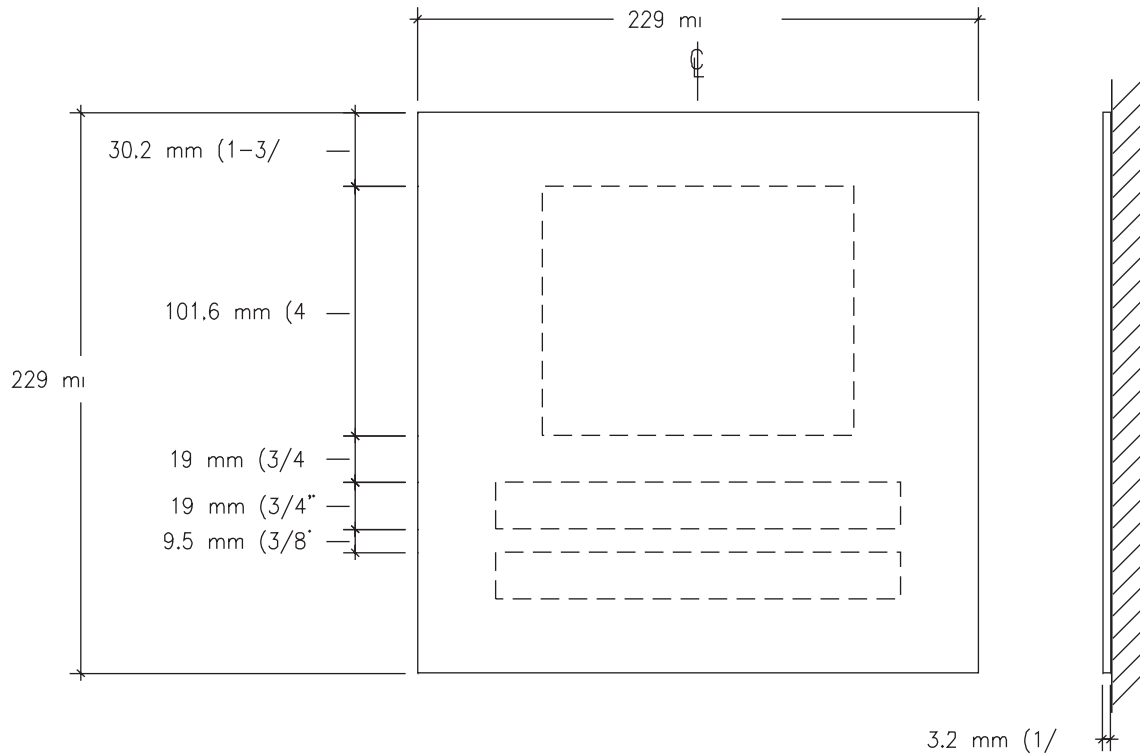
Double sided foam tape or silastic adhesive.

Installation

Centered on door, 1575 mm (63") to top of sign.

High Voltage Warning Sign

High Voltage Warning Sign



Size

229 mm H x 229 mm W
(9" H x 9" W)

Description & Use

Caution information regarding biohazard materials. Sign is to be installed on the doors to all rooms where there is biohazard materials.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Acrylic Plaque

Graphic Process

Silk-screened.

Colors

Text & Symbol: Black - T4
Background: Yellow - B8

Typography

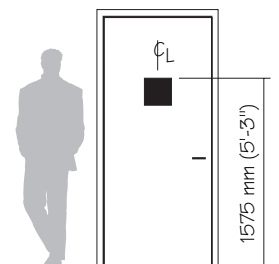
Helvetica Medium

Mounting

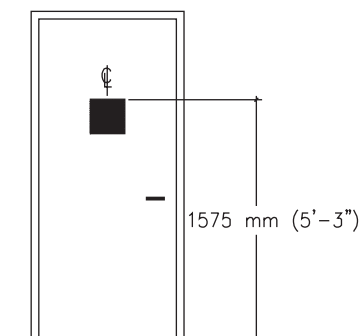
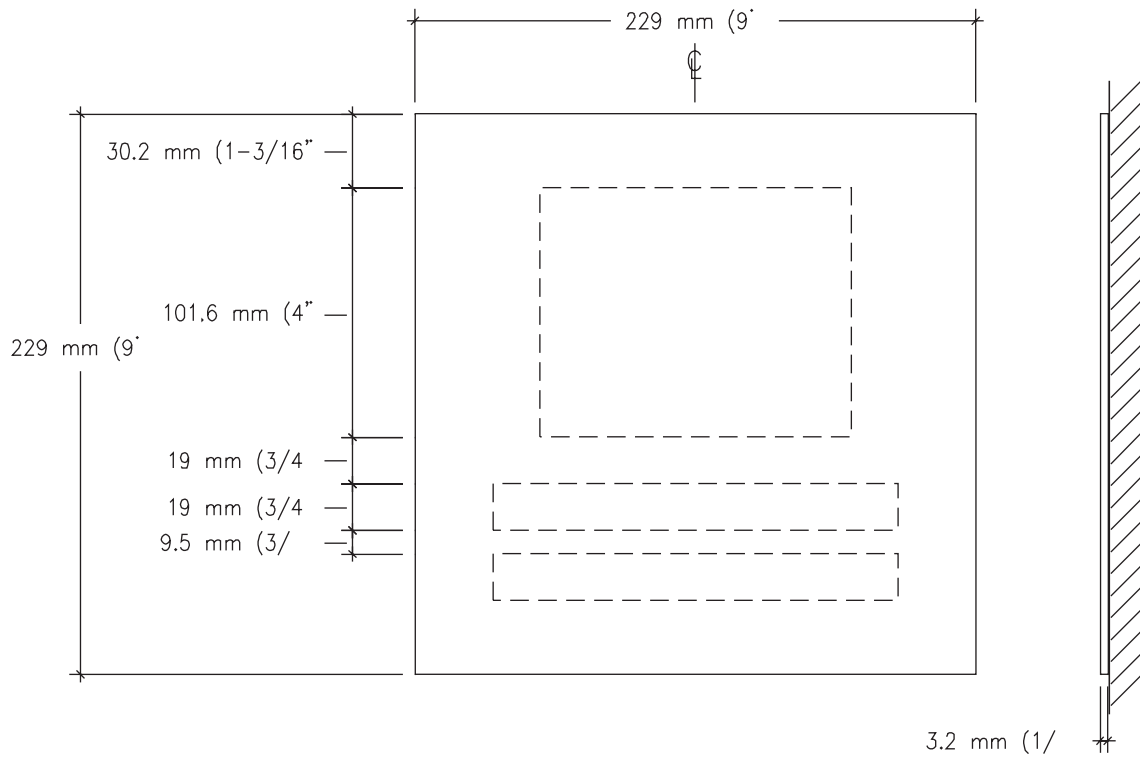
Double sided foam tape or silastic adhesive.

Installation

Centered on door, 1575 mm (63") to top of sign

Biohazard Warning Sign

Biohazard Warning Sign



Size

229 mm H x 229 mm W
(9" H x 9" W)

Description & Use

Caution information regarding lasers. Sign is to be installed on the doors to all rooms where lasers are used.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Acrylic Plaque

Graphic Process

Silk-screened.

Colors

Text & Symbol: Black - T4
Background: Yellow - B8

Typography

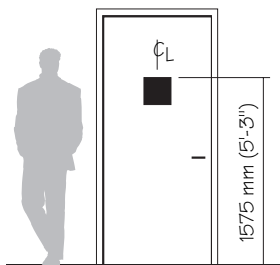
Helvetica Medium

Mounting

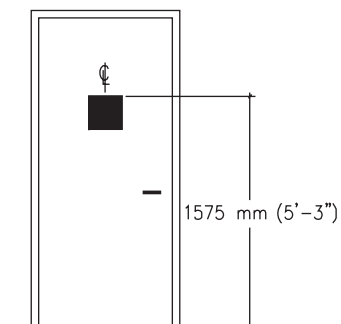
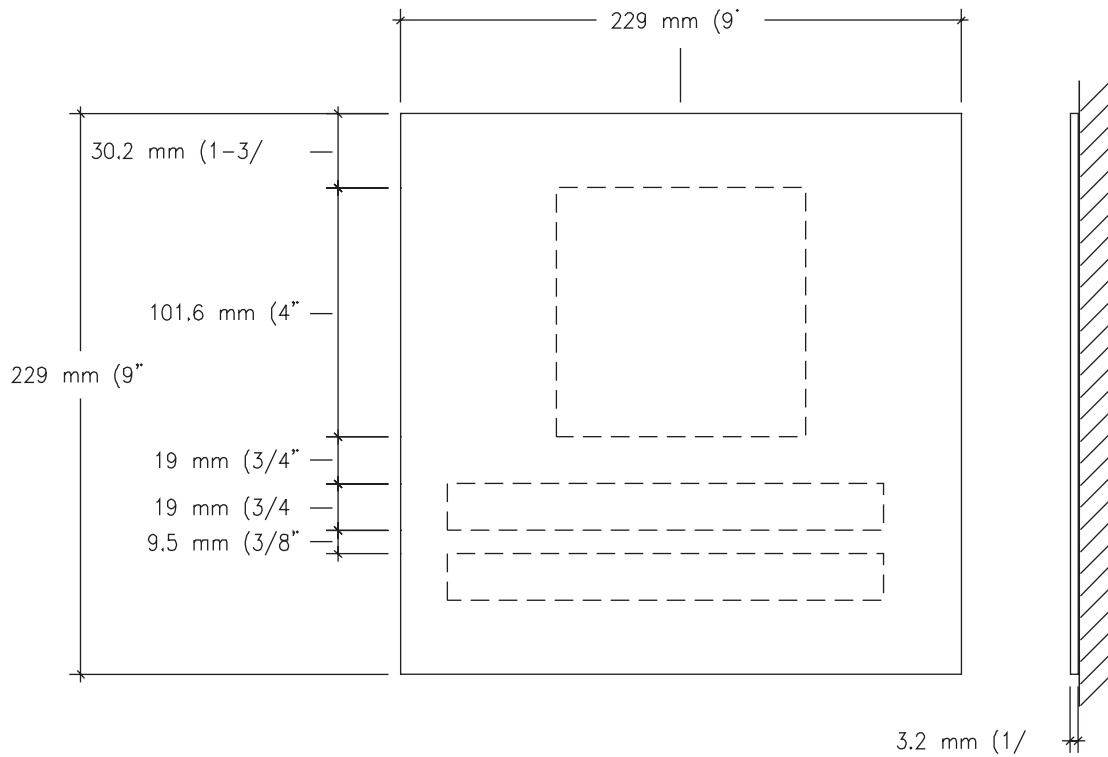
Double sided foam tape or silastic adhesive.

Installation

Centered on door, 1575 mm (63") to top of sign

Laser Warning Sign

Laser Warning Sign



Occupational Exposure Area Warning Sign**Size**

229 mm H x 229 mm W
(9" H x 9" W)

Description & Use

Caution information regarding occupational exposure. Sign is to be installed on doors to all rooms where there is occupational exposure.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Acrylic Plaque

Graphic Process

Silk-screened.

Colors

Text: Black - T4
Background: Yellow - B8

Typography

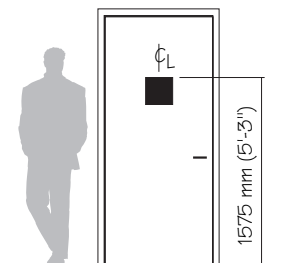
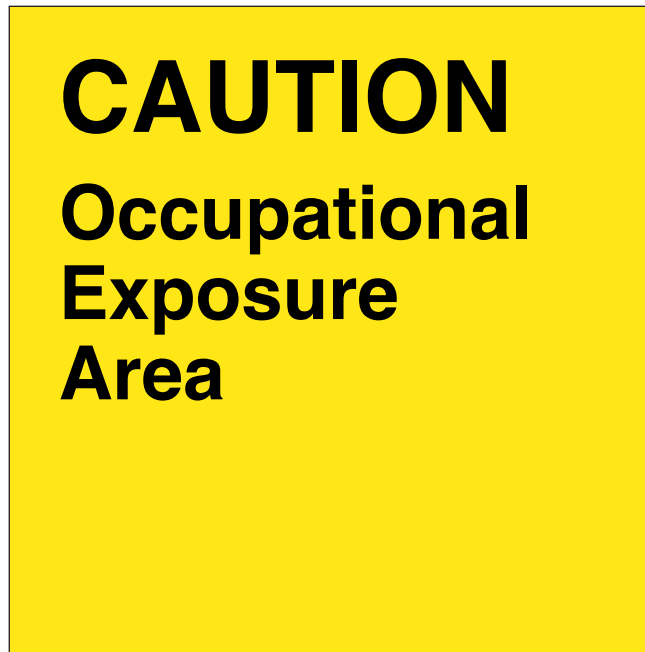
Helvetica Medium

Mounting

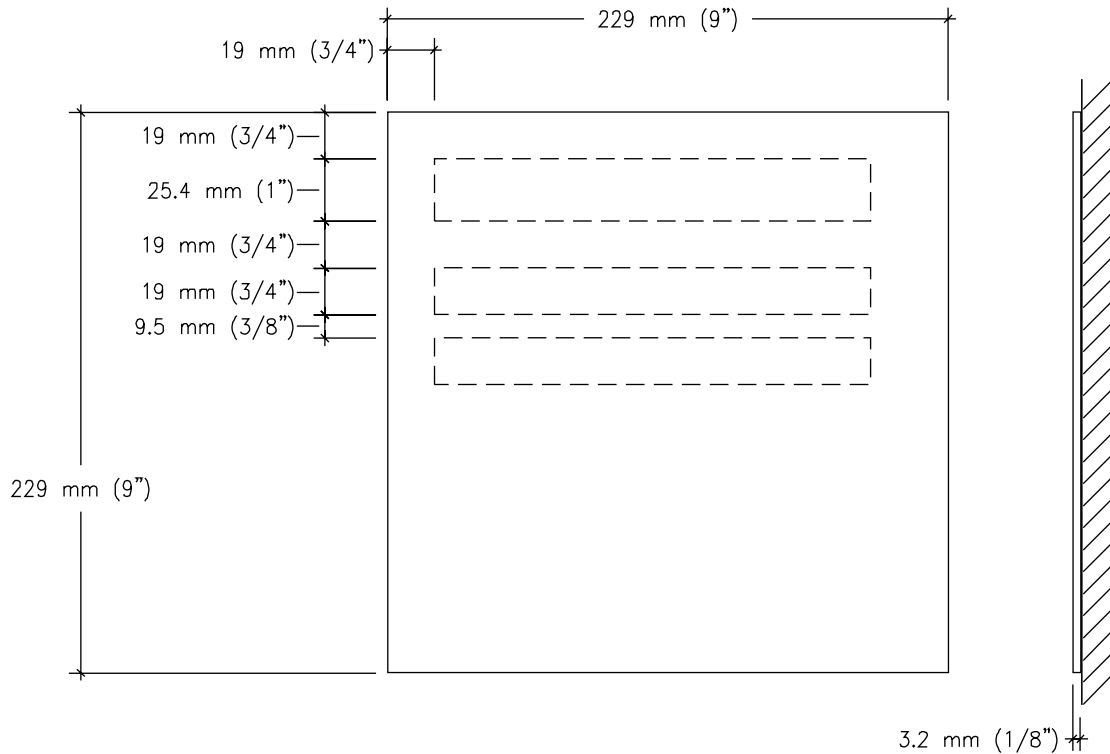
Double sided foam tape or silastic adhesive.

Installation

Centered on door, 1575 mm (63") to top of sign.



Occupational Exposure Area Warning Sign



Sign Size

229 mm H x 229 mm W
(9" H x 9" W)

Description & Use

No Re-Entry Floor Sign is used to identify a door to a stairwell or other locations, which when used will not allow re-entry.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Acrylic Plaque

Graphic Process

Silk-screened

Colors

Text: Refer to Color Chart.

Background: Refer to Color Chart.

Typography

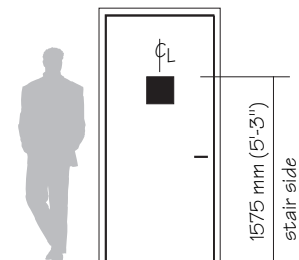
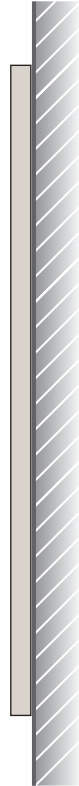
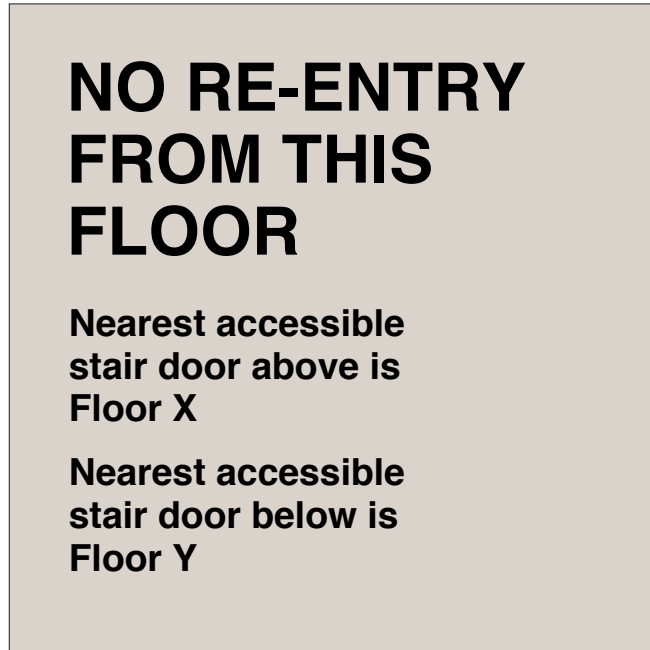
Helvetica Medium

Mounting

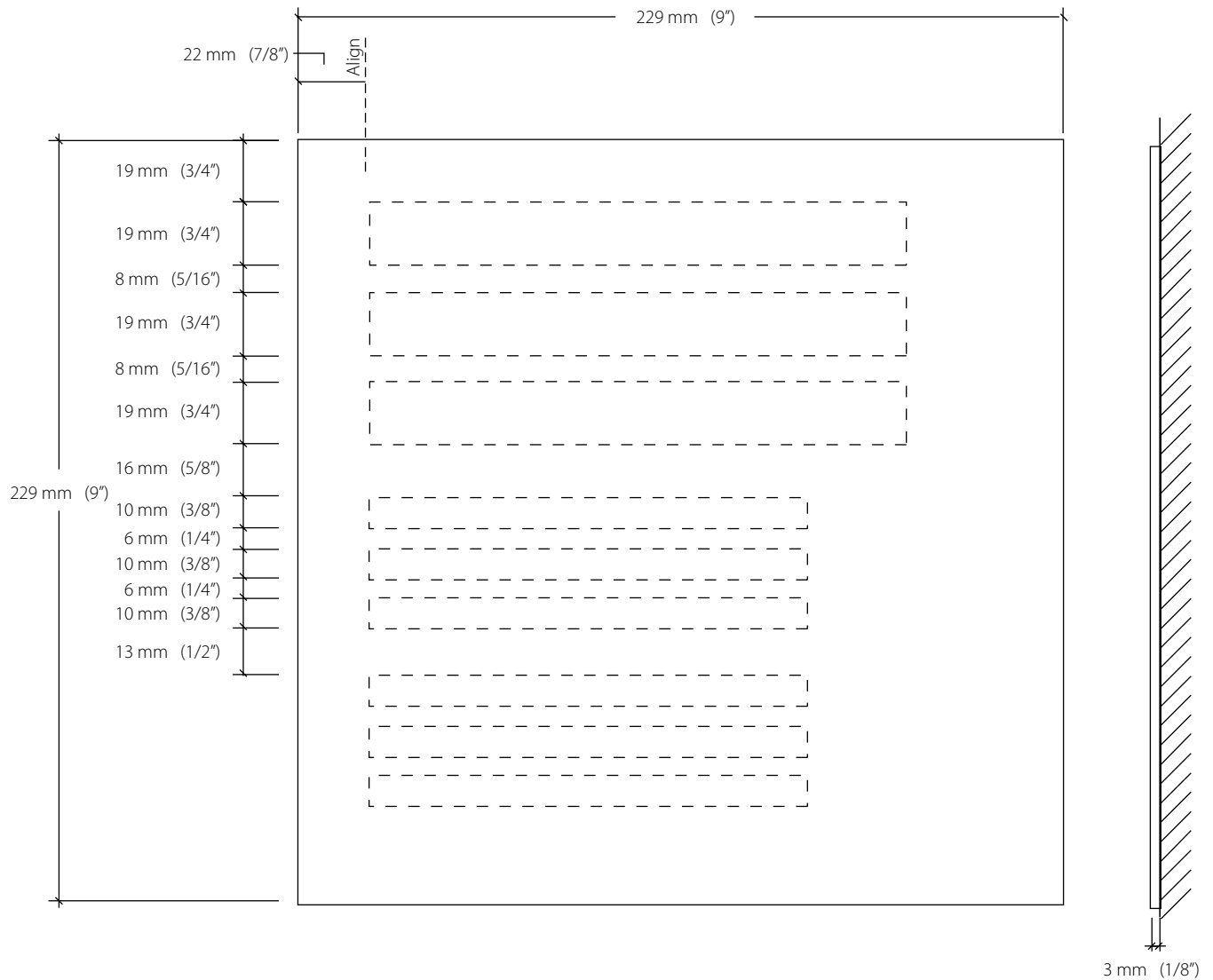
Double sided foam tape or silastic adhesive.

Installation

Centered on door, 1575 mm (63") to top of sign

No Re-Entry Floor Sign

No Re-Entry Floor Sign



Size

152 mm H x 152 mm W
(6" H x 6" W)

Description & Use

Push To Exit Sign is used to inform type of action needed to activate door. Sign is to be installed on doors to all exits where push motion is needed to activate door.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Acrylic Plaque

Graphic Process

Silk-screened.

Colors

Text: Refer to Color Chart.

Background: Refer to Color Chart.

Typography

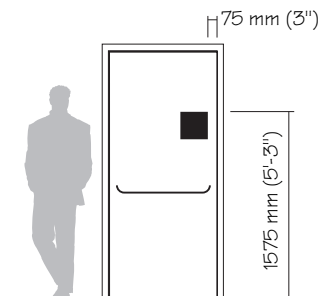
Helvetica Medium

Mounting

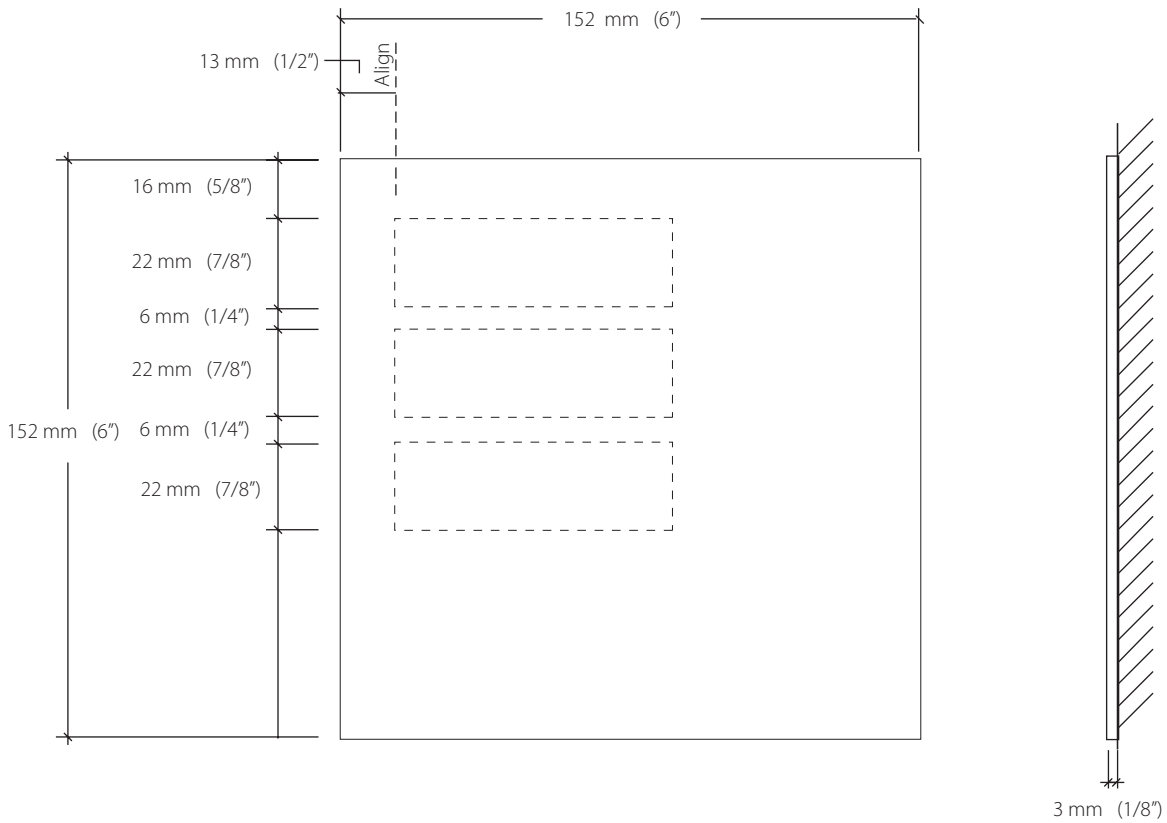
Double sided foam tape or silastic adhesive.

Installation

Knob side of door, 1575 mm (63") to top of sign and 50 mm (2") over from door frame.

Push To Exit Sign

Push To Exit Sign



Size

76 mm H x 229 mm W
(3" H x 9" W)

Description & Use

Emergency Push To Open Sign is used to inform type of action needed to activate door in case of an emergency. Sign is to be installed next to doors at all exits where push motion is needed to activate door.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Acrylic Plaque

Graphic Process

Silk-screened.

Colors

Text: Refer to Color Chart.

Background: Refer to Color Chart.

Typography

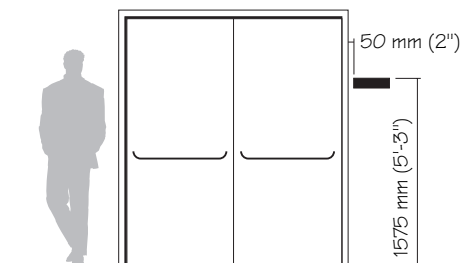
Helvetica Condensed Bold

Mounting

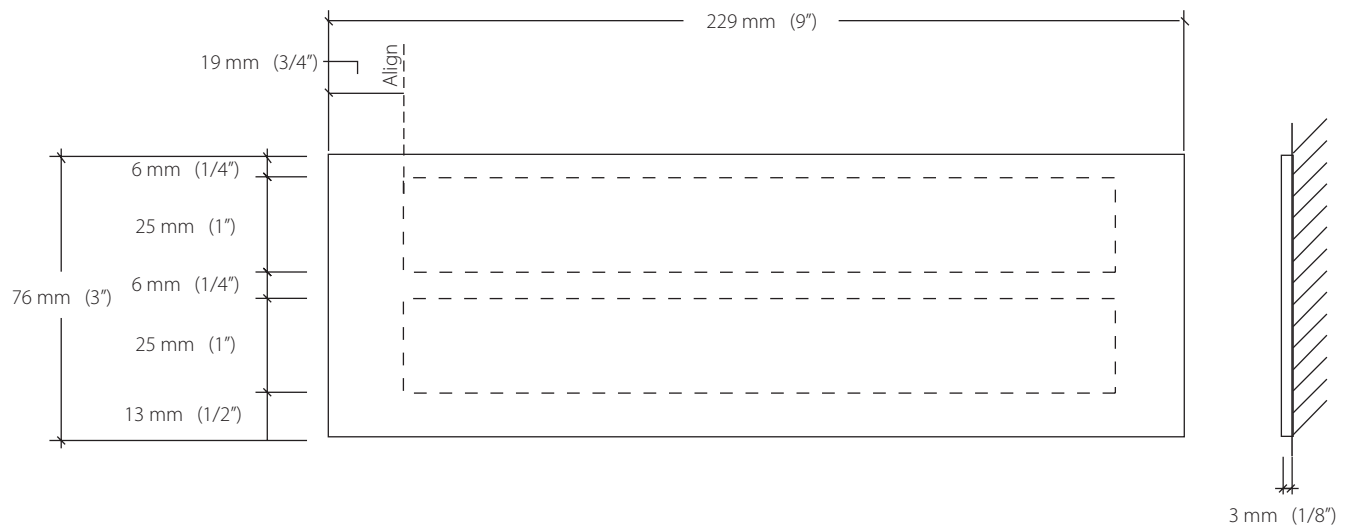
Double sided foam tape or silastic adhesive.

Installation

Knob side of door, 1575 mm (63") to top of sign and 50 mm (2") over from door frame.



Push To Exit Sign



Size

76 mm H x 229 mm W
(3" H x 9" W)

Description & Use

Emergency Slide To Open Sign is used to inform type of action needed to activate door in case of an emergency. Sign is to be installed next to doors at all exits where slide motion is needed to activate door.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Acrylic Plaque

Graphic Process

Silk-screened.

Colors

Text: Refer to Color Chart.

Background: Refer to Color Chart.

Typography

Helvetica Condensed Bold

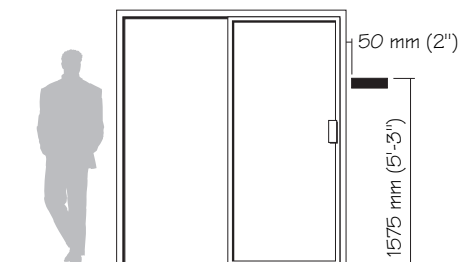
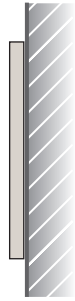
Mounting

Double sided foam tape or silastic adhesive.

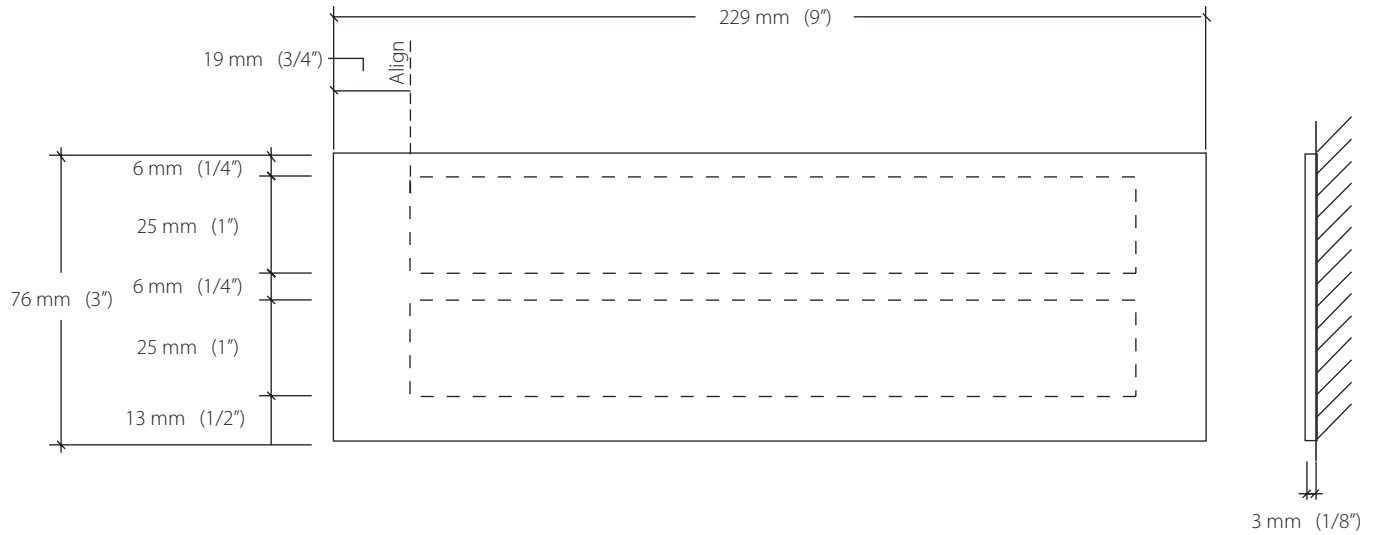
Installation

Knob side of door, 1575 mm (63") to top of sign and 50 mm (2") over from door frame.

**In emergency,
slide to open.**



Emergency Slide To Open Sign



Size

229 mm H x 229 mm W
(9" H x 9" W)

Description & Use

Direction of Exit Sign used to indicate direction egress. Sign is to be installed next to doors at all exits where direction is needed to exit.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Acrylic Plaque

Graphic Process

Silk-screened.

Colors

Text: Refer to Color Chart.
Background: Refer to Color Chart.

Typography

Helvetica Medium

Mounting

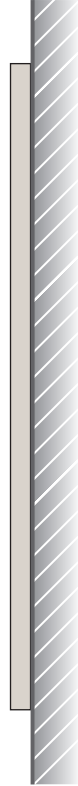
Double sided foam tape or silastic adhesive.

Installation

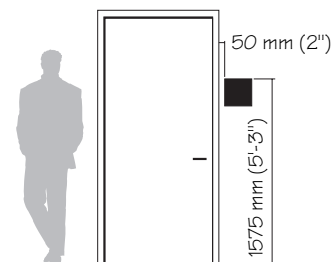
Knob side of door, 1575 mm (63") to top of sign and 50 mm (2") over from door frame.

Direction Of Exit Sign

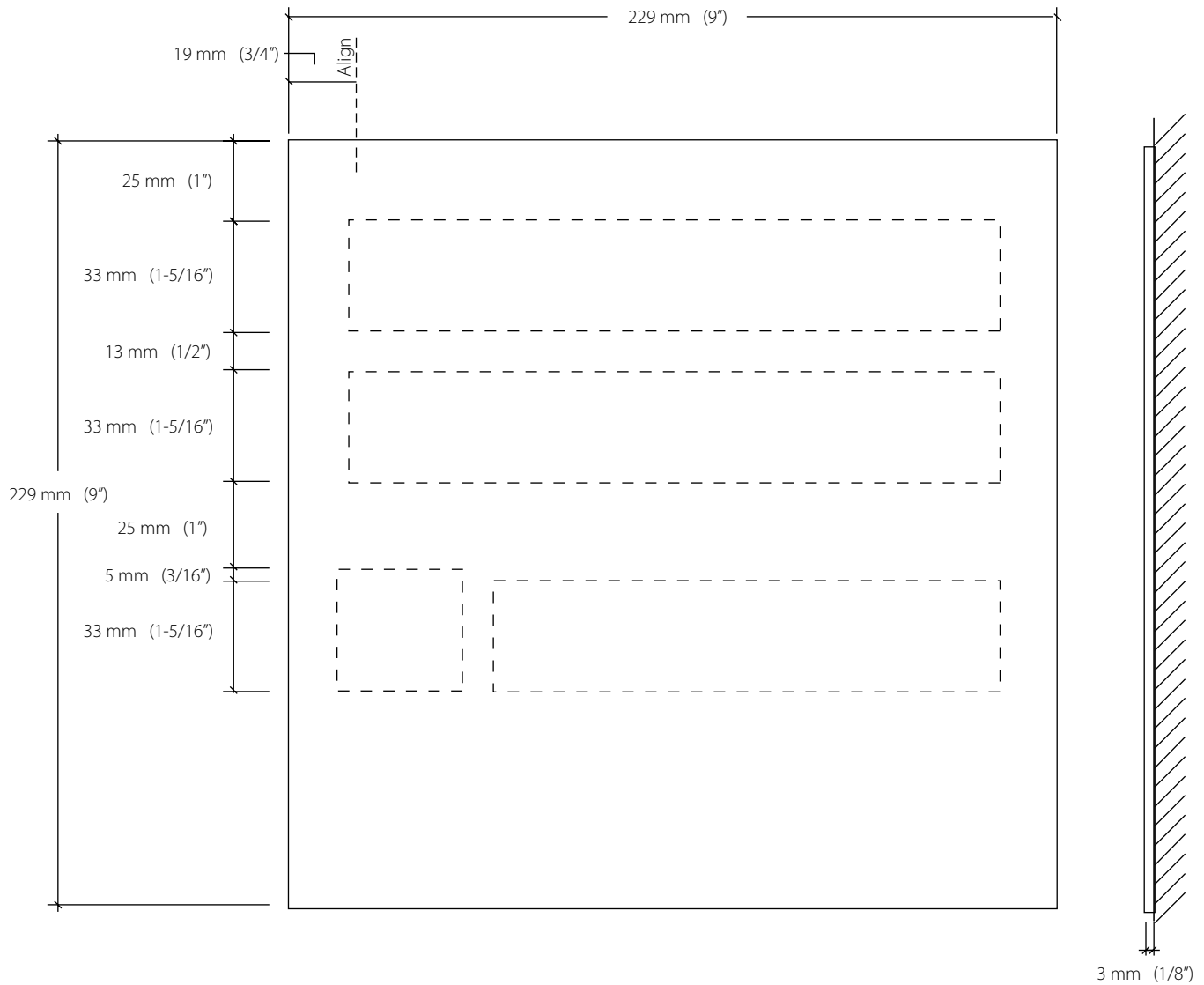
Message Layout A



Message Layout B



Direction Of Exit Sign



Sign Size

229 mm H x 229 mm W
(9" H x 9" W)

Description & Use

No Re-entry Sign is used to identify an exit door which when used will not allow re-entry into room, floor or building.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Acrylic Plaque

Graphic Process

Silk-screened

Colors

Text: Refer to Color Chart.

Background: Refer to Color Chart.

Typography

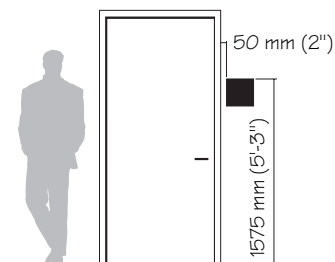
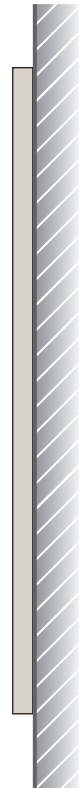
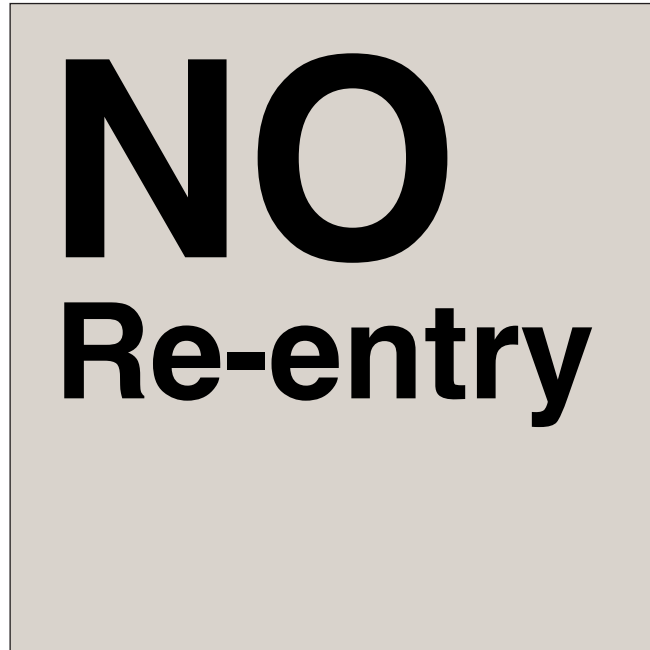
Helvetica Medium

Mounting

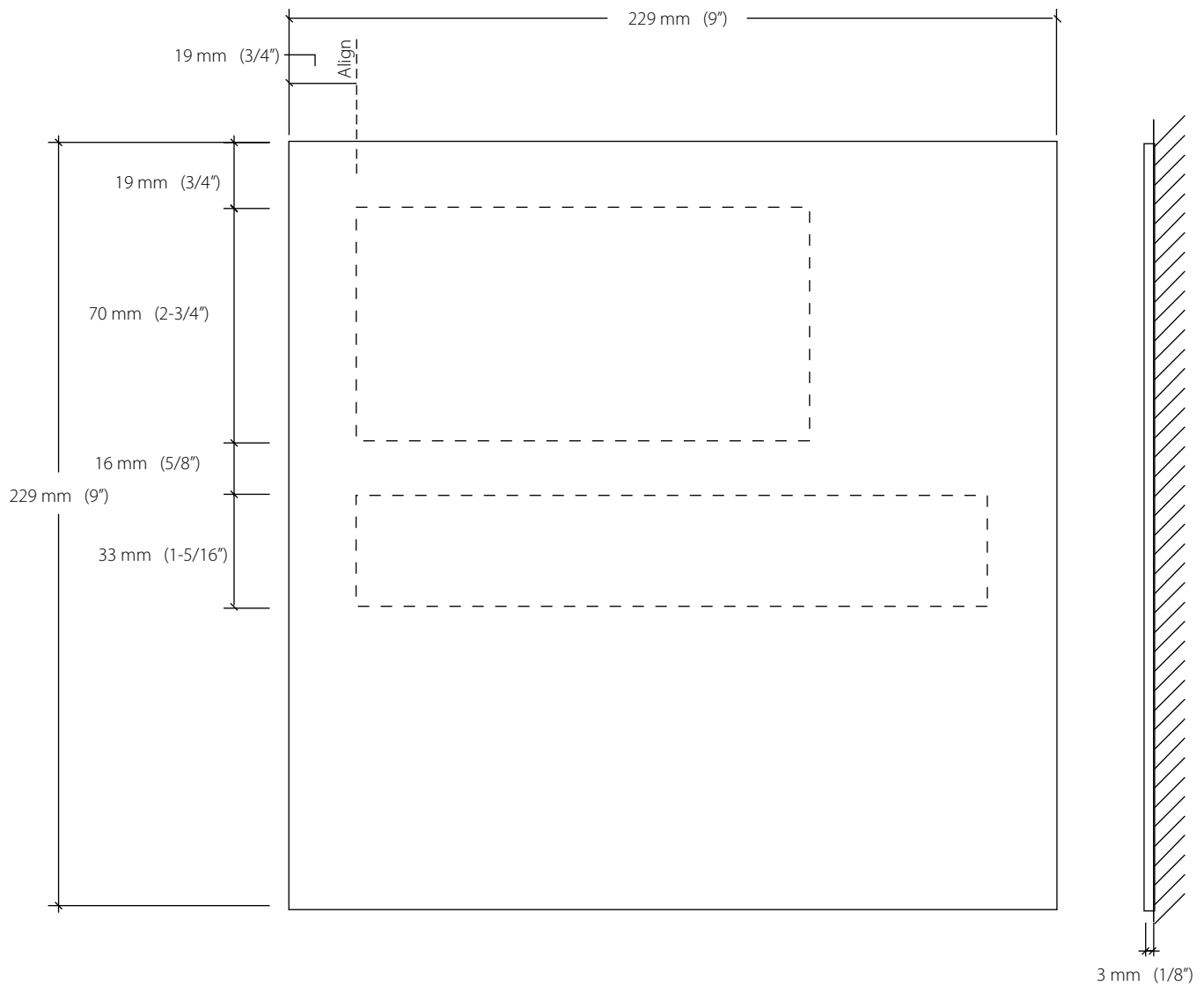
Double sided foam tape or silastic adhesive.

Installation

Centered on door, 1575 mm (63") to top of sign



No Re-entry Sign



Sign Size

229 mm H x 229 mm W
(9" H x 9" W)

Description & Use

Fire Equipment Identification Sign is a flag sign used to locate fire equipment cabinet.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Acrylic Plaque with aluminum bracket for flag mounting

Graphic Process

Silk-screened

Colors

Text & Symbol: White - T1
Background: Red - B3
Bracket: Aluminum - P2

Typography

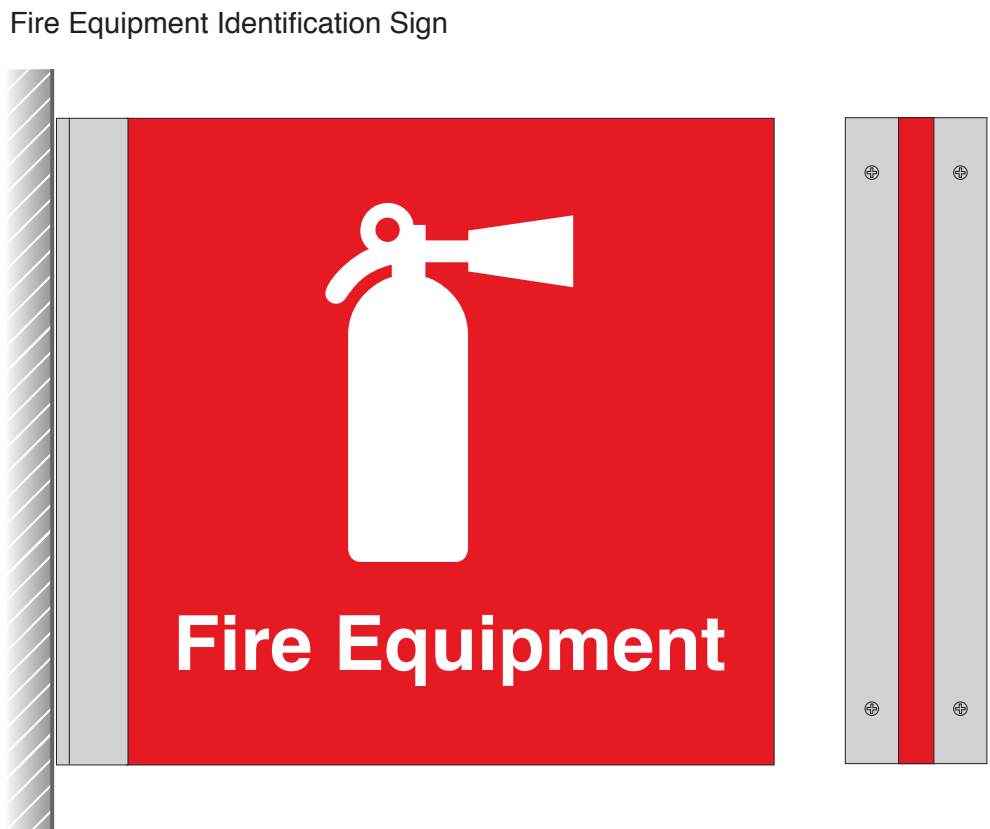
Helvetica Medium

Mounting

Double sided foam tape or silastic adhesive and mechanical fasteners with anchors.

Installation

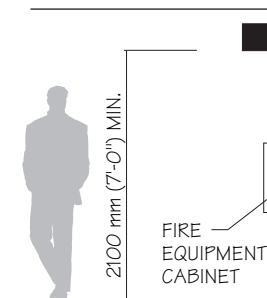
Centered above fire equipment cabinet a 2100mm (7'-0") to bottom of sign, mechanically fastened to wall with expandable anchors as needed for wall type.



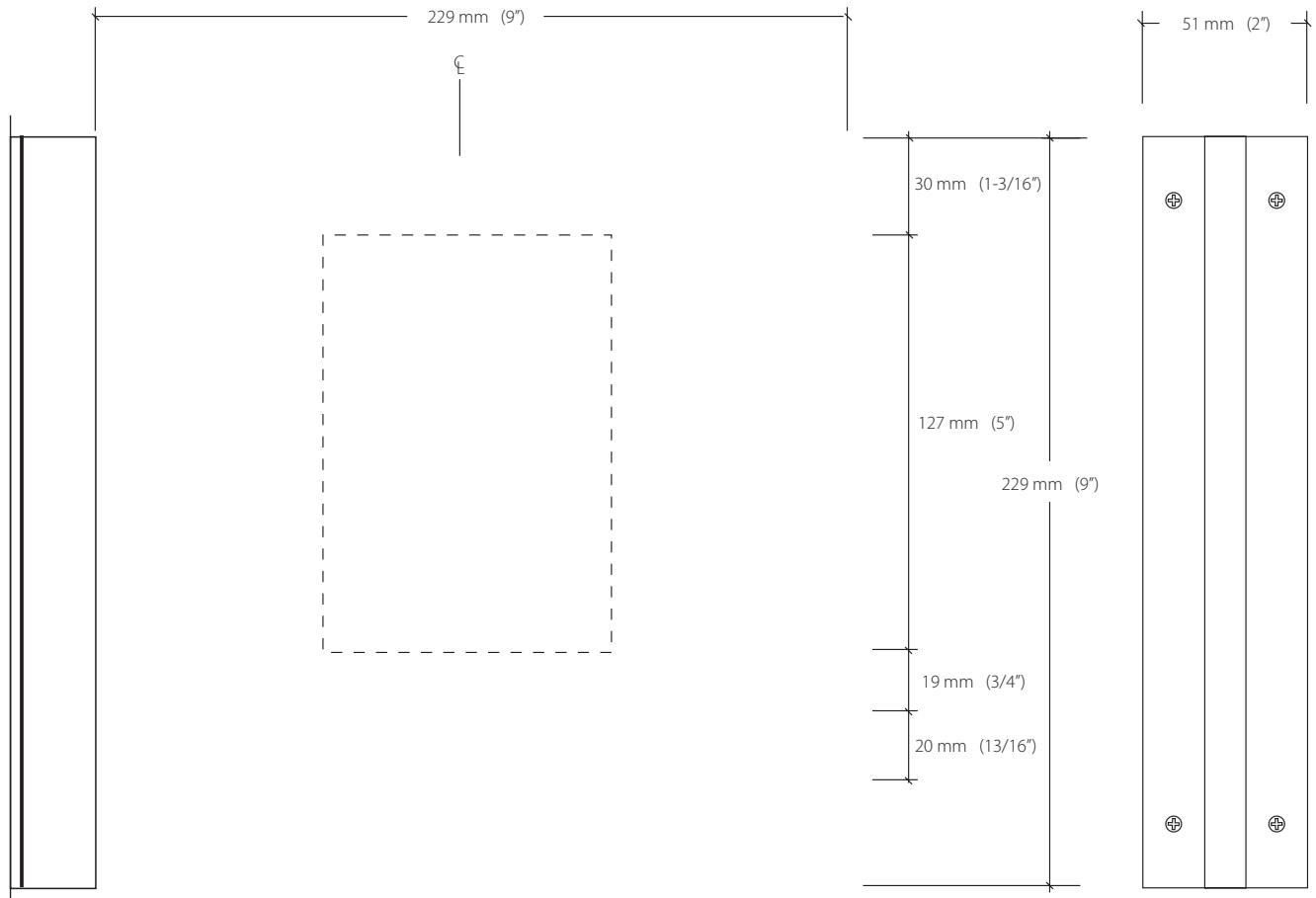
Side A



Side B



Fire Equipment Identification Sign



Sign Size

152 mm H x 152 mm W
(6" H x 6" W)

Description & Use

Pregnant notification sign is used to convey a request for patient information. Sign is placed in patient waiting areas and treatment rooms.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Acrylic Plaque

Graphic Process

Silk-screened

Colors

Text: Refer to Color Chart.

Background: Refer to Color Chart.

Typography

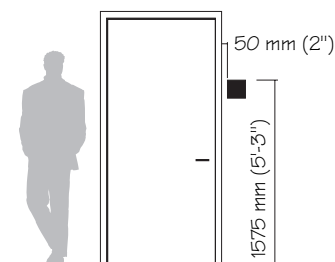
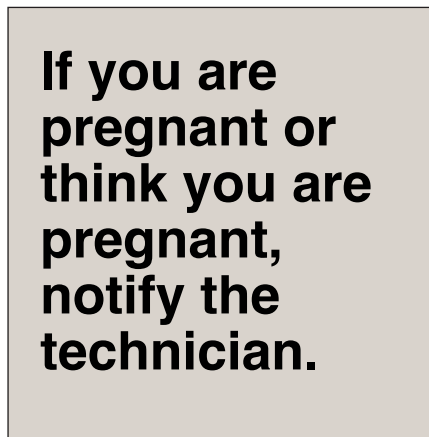
Helvetica Medium

Mounting

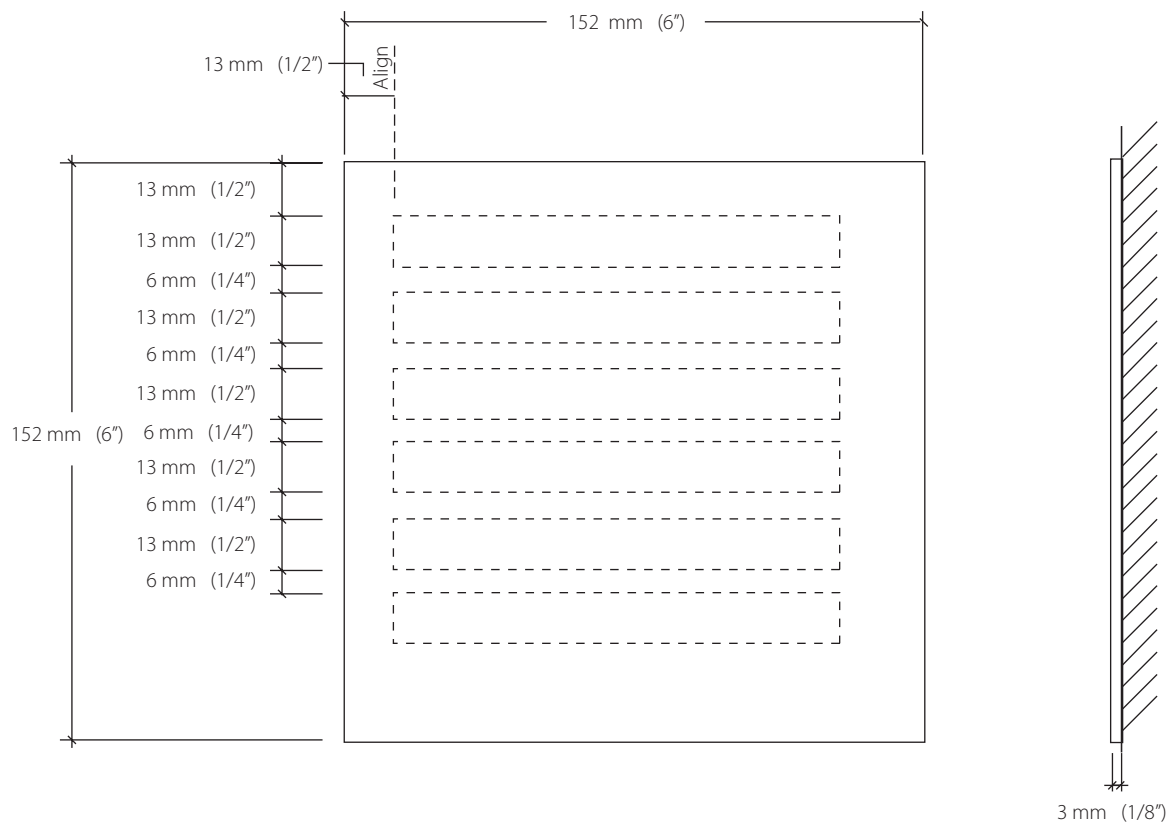
Double sided foam tape or silastic adhesive.

Installation

Centered on door, 1575 mm (63") to top of sign

Pregnancy Notification Sign

Pregnant Notification Sign



Sign Size

229 mm H x 229 mm W
(9" H x 9" W)

Description & Use

Re-entry Sign is used to identify an entry door which when used will allow re-entry into room, floor or building.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Acrylic Plaque

Graphic Process

Silk-screened

Colors

Text: Refer to Color Chart.

Background: Refer to Color Chart.

Typography

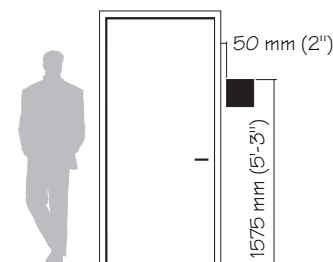
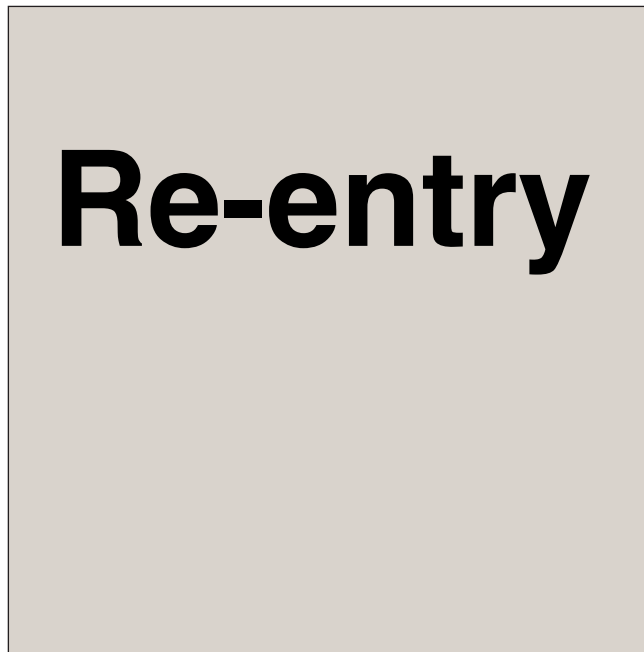
Helvetica Medium

Mounting

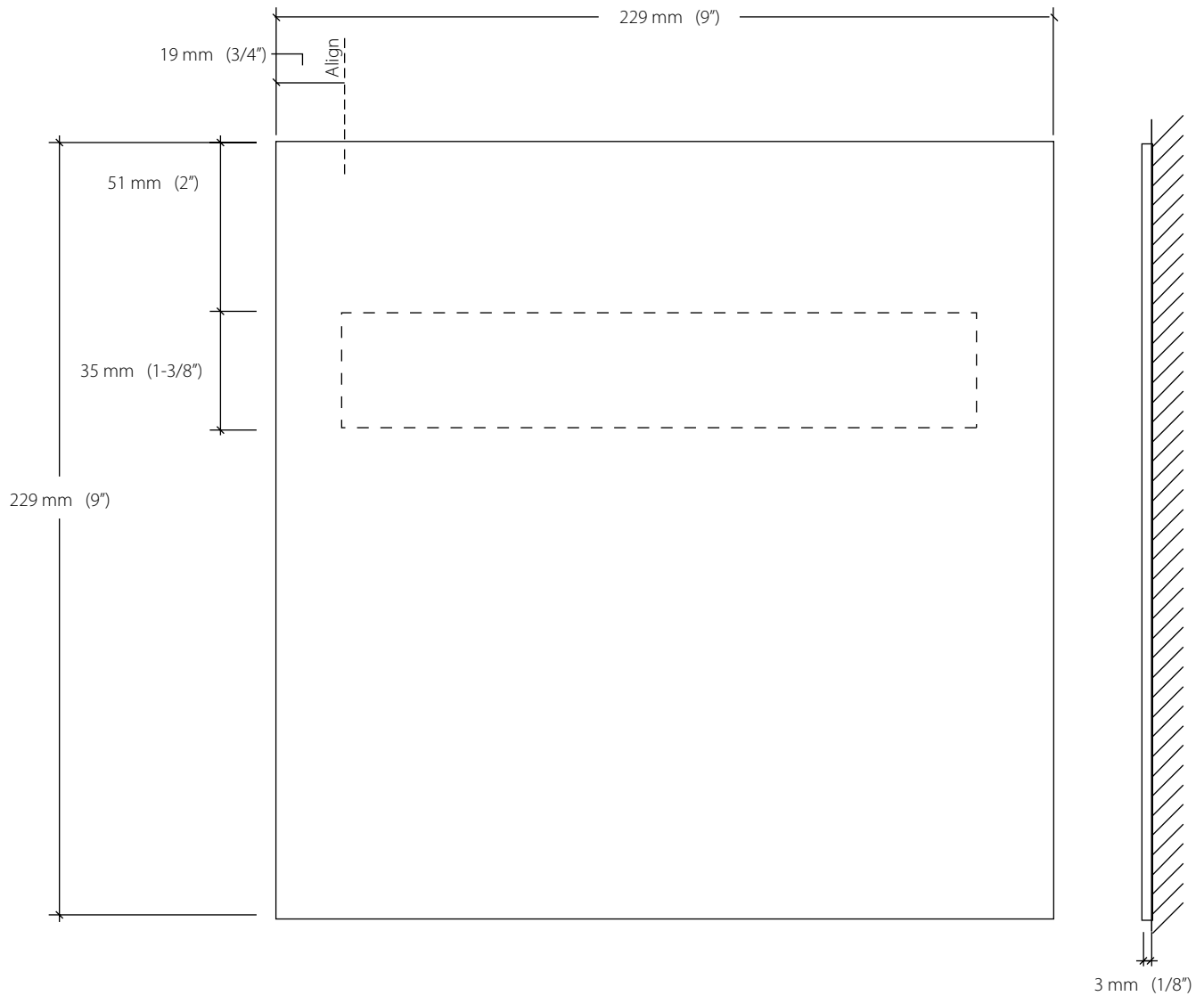
Double sided foam tape or silastic adhesive.

Installation

Centered on door, 1575 mm (63") to top of sign

Re-entry Sign

Re-entry Sign



The specifications for interior signs are available in the Master Construction Specifications area of the VA Technical Information Library.

http://www.va.gov/facmgt/standard/spec_10.asp

Refer to Specification 10440.

For more information regarding specifications, contact the Office of Facilities Management, Standards Service.

The specifications will require editing to eliminate signs that are not needed and to adapt the specifications to the specific project for which they are intended.

The specifications require close coordination taking into account the existing sign program at a medical center, sign maintenance and future signing needs.

The sign message schedule is considered a part of the specifications and would comprise the last section. Configuration of the message schedule may vary according to project requirements.

The sign message schedule form, illustrated in the Programming Section of this Handbook, lists the typical information that a sign manufacturer and installer will require.

The sign message schedule needs to be coordinated with a sign location plan drawing showing where signs are to be placed within a building or on the site. See the example in the Programming Section of this Handbook.

The Life Safety & Code sign types are constructed from painted acrylic panels with screened arrows, symbols and copy

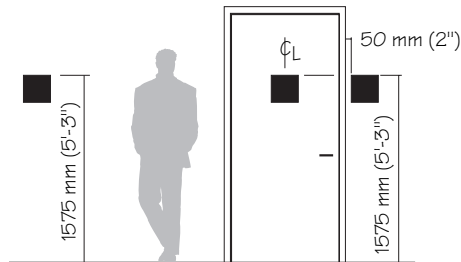
For Braille and assembled signs see Construction section from the Interior Signs portion of the manual for more information.

Placement: Wall & Door Mounted Signs

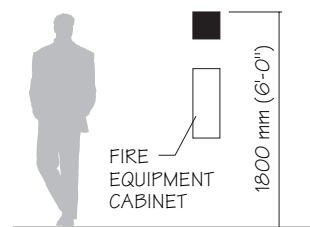
The location and placement of Life Safety & Code signs are very specific and based upon its use, function and code requirements.

Each type of sign should be installed as show in the following illustration, with out deviation. This may require that furniture be moved, bulletin boards be relocated, etc to ensure that the Life Safety & Code sign is installed in its correct location.

Refer to interior sign section for installation method and materials.



Detail: 1



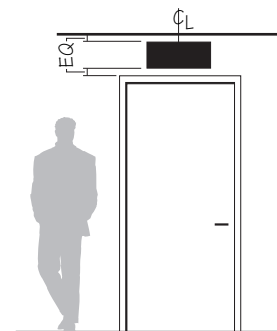
Detail: 2

LS Intallation Detail 1

Sign types: IN-01.01, IN-01.03, IN-01.05, IN-01.10, IN-01.12, IN-01.16, IN-01.17, IN-01.18, IN-01.19, IN-01.20, IN-01.21, IN-01.22, IN-01.23, IN-01.24, IN-01.25, IN-01.32, IN-01.33



Detail: 3



Detail: 4

LS Intallation Detail 2

Sign type: IN-01.02

LS Intallation Detail 3

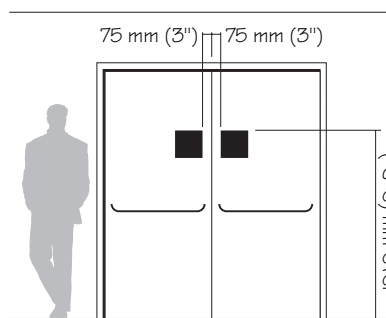
Sign type: IN-01.04

LS Intallation Detail 4

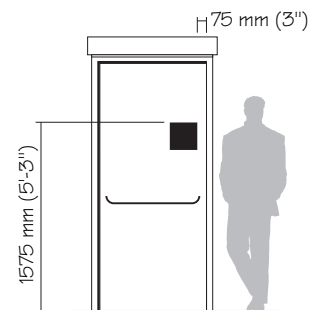
Sign type: IN-01.07

LS Intallation Detail 5

Sign type: IN-01.08



Detail: 5



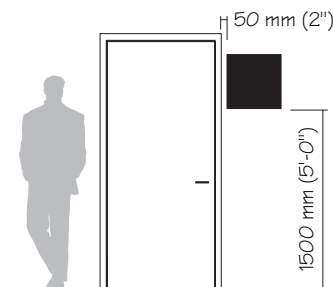
Detail: 6

LS Intallation Detail 6

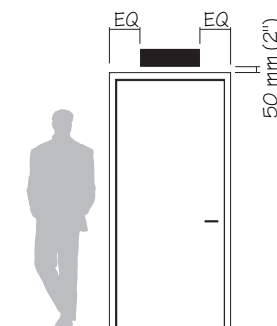
Sign type: IN-01.09

LS Intallation Detail 7

Sign type: IN-01.11



Detail: 7



Detail: 8

LS Intallation Detail 8

Sign type: IN-01.14

LS Intallation Detail 9

Sign type: IN-01.15

LS Intallation Detail 10

Sign type: IN-01.26

LS Intallation Detail 11

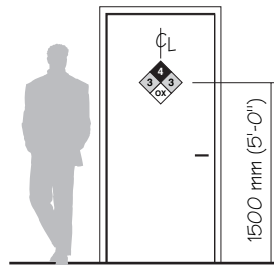
Sign type: IN-01.27

LS Intallation Detail 12

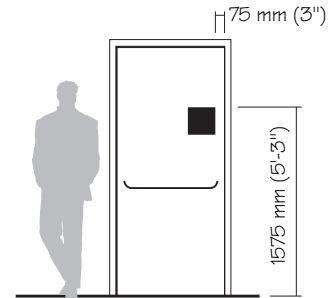
Sign type: IN-01.28

LS Intallation Detail 13

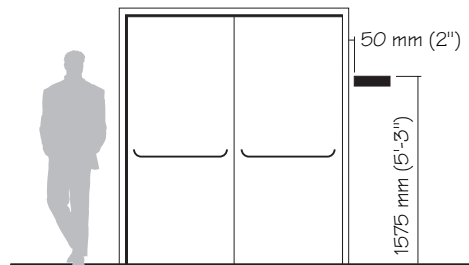
Sign type: IN-01.31



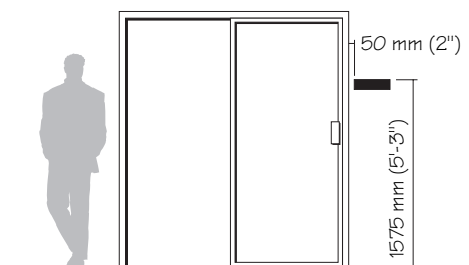
Detail: 9



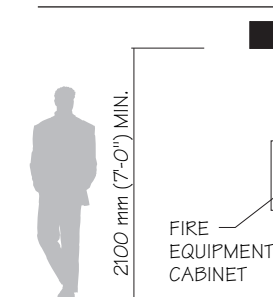
Detail: 10



Detail: 11



Detail: 12



Detail: 13

Glass Back Up

Certain signs may require that they be installed on glass because there is no available wall surface.

When this situation occurs, a blank glass back up is required to be placed on the opposite side of the glass exactly behind sign being installed.

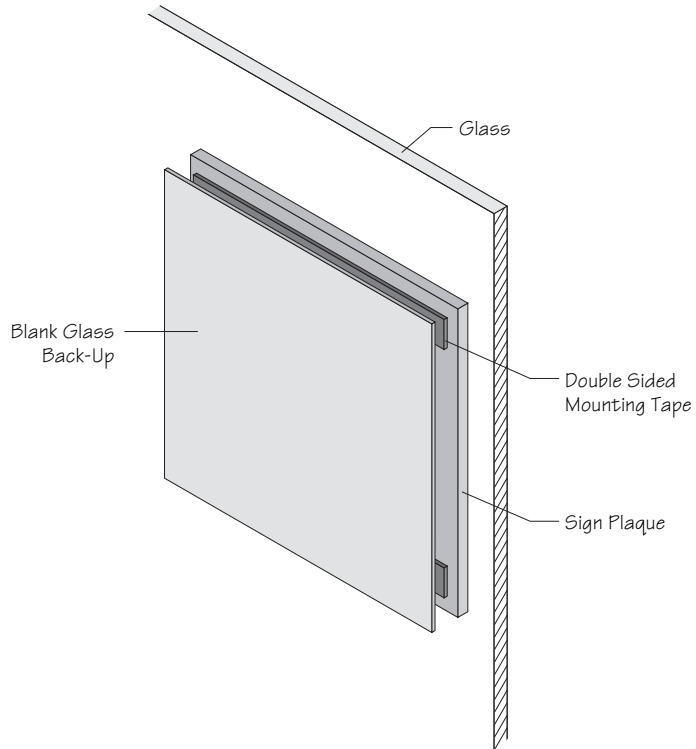
This blank opaque glass back up is to be the same size and color as the sign being installed so it effectively covers and hides the mounting of the sign to the glass.

Glass Back Up

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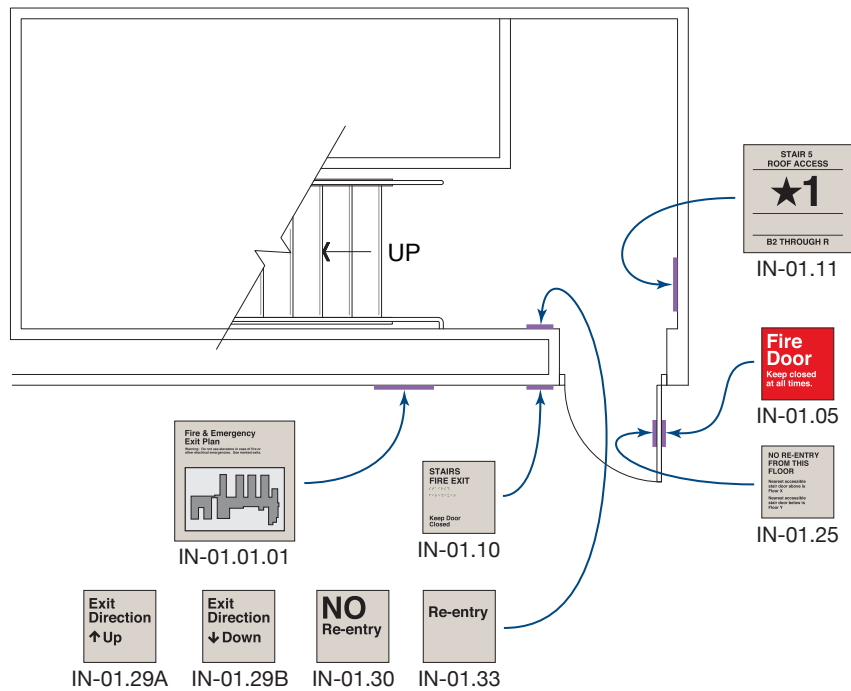
This blank opaque glass back up is to be the same size and color as the sign being installed so it effectively covers and hides the mounting of the sign to the glass.



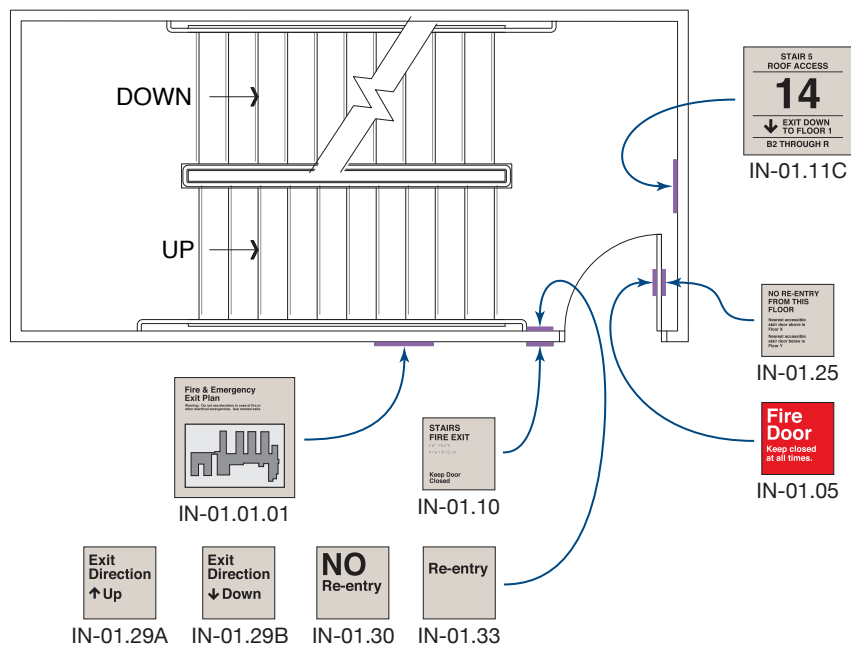
Stairwell Guide

Certain signs relating to stairs require that they be installed at specific locations as defined by what floor they are located on.

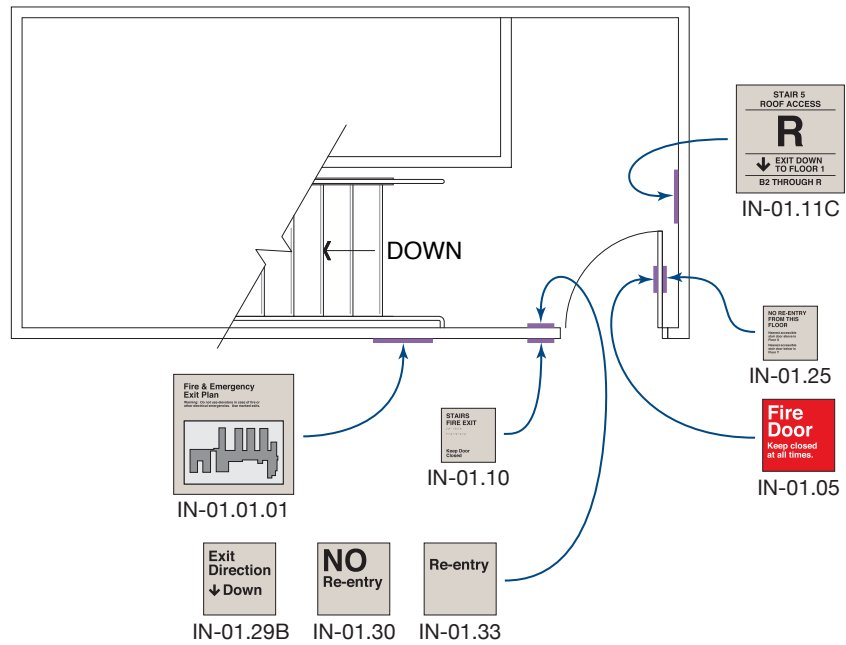
Ground Level



Intermediate Floor Levels



Roof Level





Interior Signs

- Room Identification
- Conference Room
- Wall Directional
- Ceiling Directional
- Department Identification
- Directories
- Building Entrance
- Letters

Section 6: Interior Signs

▪ Planning	Pages 6-2-1 through 6-2-6
▪ Helpful Hints	Pages 6-3-1 through 6-3-2
▪ Overview	Pages 6-4-1 through 6-4-5
▪ Sign Type Drawings	Pages 6-5-1 through 6-5-66
▪ Specification	Page 6-6-1
▪ Construction	Pages 6-7-1 through 6-7-9
▪ Installation	Pages 6-8-1 through 6-8-6

Planning an Interior Sign Program

The development of an effective working interior sign program requires the coordination of several interlaced criteria.

For an effective interior sign program you have to take in to account to the following:

1. Location of building entrances and elevators.
2. Character and configuration of the corridor system.
3. How do visitors currently walk around the building(s).
4. What is the desired path of travel within the building for visitors and patients.
5. What is the desired path of travel within the building for employees.
6. Location of departments and clinics.
7. A simple clear room numbering system that follows a clear, understandable pattern.
8. Placement of signs in locations where people are expecting them to be.
9. Adequate light on and around directional signs.
10. Which signs can have permanent messages and which ones need to be changeable.

These elements help establish the basis of a clear sign program that communicates and informs in a direct and simple manner.

A sign program for a building, that works well, is one that has been planned as an integrated whole. This means signs are coordinated from the main entrance, to the directional signs and department identification and to room identification signs.

Types of Signs

Interior signs have been identified, on each page, with a description of their use and application.

All rooms in a facility should be labeled with a room number sign. Other types of signs, depending on the room use, then augment this room number sign, a Type IN-03. For example: an IN-04 would be added for labeling a Soiled Utility room or an IN-07 for identifying a Conference Room.

Wall, soffit and ceiling mounted directional signs provide solutions for communicating way finding information in differing building conditions. Typically, ceiling or soffit mounted directional signs are used to display directional information for high traffic destinations like the Pharmacy or Clinics.

Directories in lobbies and at elevator landings serve to assist people in finding or confirming the location of services within a building or in other buildings. Directories, because of their capability to handle a large number of services listing, can include all of the departments or services within the facility.

Sizes of Signs & Lettering

Interior sign sizes that are illustrated in this section have been determined to work in most situations. The size of text shown has also been determined to be the best compromise between readability and being able to fit text on the sign.

When planning a sign program, look for conditions that are within the building where signs will not fit. All buildings have these conditions. When encountered, have the specific sign, at that location, modified in size to fit the specific condition requirements.

Text size on signs has also been predetermined to meet ADA requirements for the vision impaired. Overhead signs require large size lettering and lettering on directional signs should be larger than on room identification signs.

Wayfinding “Wayfinding” is a term that in recent years has been used to describe the process of finding a destination in the built environment. Signs play an active role in this process by providing the primary form of communication in way finding

In developing a way finding system for the interior of a medical center, or the interior of a support building, you need to follow some common guidelines.

One first needs to identify the paths of travel from originating points to destinations.

In the interior of a building this involves the corridor system from all the building entrances to the locations where patients and visitors are seeking a service. While this is a primary path, a secondary primary path is from that service or location to another service or location within the building. Like going from a Clinic to the Pharmacy.

Identifying destinations people walk to is the process of identifying the paths of transit. Way finding is then communicating to people along this pathway, with appropriate directional signs.

The intersections along the corridor pathway system need to be identified in their importance for communication. Major high traffic corridor intersections require more communication than smaller secondary intersections.

The architectural environments in which these intersections present themselves have an effect on a way finding program. Colors of walls, types of flooring and lighting also affect way finding both in a positive and a negative way.

One must look at the path of travel and the decision points that are necessary to reach the end point and where these decision points are located. At these decision points information must be communicated in a priority of need. Departments and destinations with heavy visitor and patient traffic have the highest priority of communication in way finding.

The priority of need is defined as those departments or services that have the highest percentage of people seeking them. This high demand for information then needs to be communicated with the highest priority on directional signs along the most direct path of travel.

Overhead signs, generally, provide emphasis to high priority directional information. However, with the aged VA population and wheelchair patients, care must be taken with overhead signs to insure that these signs can be seen from a distance. If the viewing distance is too short, those that walk stooped, are in walkers or in wheelchairs will miss these signs.

Wayfinding (Cont'd) Secondary information or information that applies to a small percentage of individuals needs to be evaluated in regard to its importance. Secondary information should be relegated to the bottom of the signs and not even be included if there is no room on the sign.

Typically a person only reads 4 to 8 messages on a directional sign. Any information that is beyond or greater than this is simply not read. Prioritization of communication of information would then in most cases cause the secondary or minor information to be left off the sign because it is not useful.

People that are walking have the opportunity to read more messages than an automobile driver so interior directional signs can contain more listings of information. But, more than 10 listings on a sign results in a sign so large that it is no longer readable and the viewer simply cannot sort through all the information presented, or won't stand there long enough to read everything. When a lot of information needs to be presented, break it down into smaller groups of information. Use 2 directional signs instead of 1. Place all the directional information for one direction on one sign and then use another sign to convey the other directional information.

"You Are Here" maps can sometimes aid in the way finding process but care must be taken to make sure the map is very simple and configured in a manner which it makes very easy to understand. The orientation of these maps, and the amount of information on them, plays a critical role on the understanding of the viewer of what they are looking at.

It is important that "You Are Here" maps be placed in a strategic location where the viewer has a clear orientation to the building based upon the view of the map that they are seeing. Placement also needs to be at a location in the building where the viewer can make connection with major visual objects like an atrium or large "art" or architectural feature.

Remember, once the viewer leaves the map, the visual image in their memory will quite quickly erode. And, once they make the first turn all their orientation will be gone.




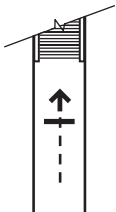

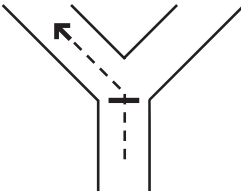

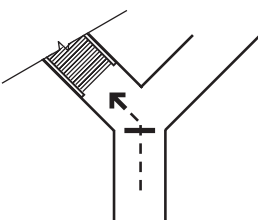

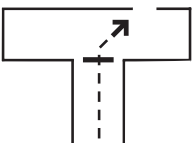

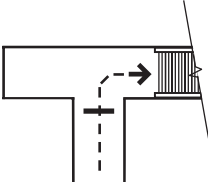
Arrows The proper use of arrows on directional signs is important to insure that the reader quickly understands the correct directional information.

Grouping all the information together that is in one direction and using one arrow is preferred. Using an arrow for each message makes the sign difficult to read.


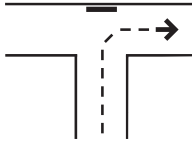

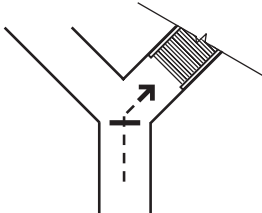

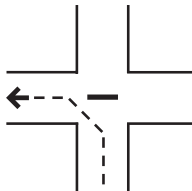

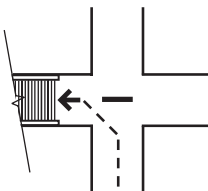

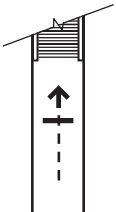


Arrows should be placed in such a manner that they visually precede the message. This allows the reader to understand direction first and information second. It also allows the arrows to be visually separated from text.

Arrows should always be larger in size than the text they are affiliated with. For example, wall directional signs have a 2-1/2" arrow and the text has a 1 3/8" capital letter size.

Orientation of arrows is important to effectively communicate direction. The following illustrations give examples of the many varied conditions that can be encountered when providing direction information.

Arrows	Number	Orientation	Location Plan	Interpretation
	①			Straight Ahead
	②			Up
	③			Ahead on Left
	④			Up on Left
	⑤			Ahead on Right
	⑥			Up on Right

Arrows (Cont'd)

Number	Orientation	Location Plan	Interpretation
⑦			Right
⑧			Down on Right
⑨			Left
⑩			Down on Left
⑪			Down
⑫			Straight Ahead

Sign Placement Correct placement of signs is required for all interior room identification signs.

Refer to the detailed drawings and instructions covered in the Installation Section for each sign type showing the placement position required for its use.

Correct placement of signs will usually mean fewer signs are required. Too many signs in one location can create a cluttered appearance and increase the difficulty for a viewer to find the particular information they are seeking.

Interior lighting, wall colors and material finishes need to be taken into consideration as this impacts the visibility of signs. Locations of glass sidelights, and their width, can require blank glass back ups or other solutions.

Coordination needs to take place with things like chart holders, bulletin boards, pictures and art work as these types of items may have to be relocated to meet the installation requirements of signs. Coordination needs to also take place with Life Safety and Code signs.

Care also needs to be taken to place signs in a manner that allow clear viewing. Placement of signs so they are not obscured by furniture or equipment is critical.

Refer to the detailed drawings and instructions covered in the Installation Section for each sign type showing the placement position required for its use.

Existing Sign Program Before implementing a new interior sign program, perform a thorough evaluation of the demolition requirements of the current sign program and the effects and impact on the facilities walls, doors and ceilings.

Check to see what is required to patch, seal and repair the building surfaces exposed as a result of removal of old signs or letters. Repairs should be planned to match adjoining surface. Evaluate if tile or stone surfaces going to require repair or refurbishment. Are doors going to need to be refinished or painted.

Make sure the sign demolition scope of work requires the contractor to close off any live electrical connections. Make sure to have existing conductors and conduit removed to the nearest junction box and made it safe.

Be sure to clearly identify any signs that are supposed to remain. It is especially important to identify signs and plaques that relate to special dedications or displays that maybe in the building.

Do not remove any life safety or code signs without having the replacement signs available and installed at the same time the old signs are removed.

The following are some general “Do’s & Don’ts” guidelines that one can refer to when developing a sign program.

key information or instructions that will hopefully reduce some common errors that are made when working out an exterior sign program.

This is not intended to be a training section of the guide, but to provide

General Guidelines

- Never use text smaller than 3” capital letter height when a sign is installed above 84” from the floor.
- All tactile room number signs or other tactile room identification signs are required to meet ADA requirement for height and Braille text.
- Signs do require maintenance and periodic cleaning will extend the life of a sign program.
- If overhead signs are used, make sure they have 84 inches of clearance from the bottom of the sign to the floor.
- Signs identifying electrical closets, mechanical rooms and telecommunication rooms should consist of only the room number which should follow the master building room numbering system. No descriptive name or title should be used nor should they have a unique number system.

Message Content

- Keep sign messages brief. Unnecessary information will confuse the viewer.
- Typically, all signs, with the exception of directional signs, should convey no more than one name, title, concept or thought.
- Use text (words) which are familiar and comfortable to the viewer, and use the same words throughout the sign program.
- On directional and informational signs only provide information necessary to make a decision at that particular location.
- Whenever possible, messages should be presented using positive information.
- On directional signs, do not anticipate decisions that can be made later. Unnecessary or premature information will confuse the reader.
- Messages placed on signs should be concise, preferably with no more than seven to ten words.

Message Layout

- Use upper and lower case text whenever possible. Upper and lower case text is easier to read and is understood faster than text in all capital letters.
- Line-spacing between two different messages should be greater than line-spacing between lines of the same multiple-line message group.
- Generally sign text should be a minimum of 1/2” capital letter height.
- Text should not be run right up to the edge of the sign.
- If a line text needs to be reduced in order to fit on a sign, use only commonly recognized abbreviations, reduce the number of words or reduce the size of the type for the entire message. DO NOT condense the type face.
- The most important message should appear as the first line text and the most important directional information should be at the top of the sign.

Placement of Signs

- Signs should, if at all possible, always be perpendicular to the intended viewer.
- Position signs with a clear line of sight from the viewing point to the sign face.
- Always evaluate the lighting at a sign's location. Lighting conditions can have a big effect on visibility possibly making a particular location unsuitable.
- All signs should be placed in a manner that will be clearly visible at all times.
- Be careful to coordinate ceiling mounted signs so they do not obstruct or block fire sprinkler systems and exit signs.
- Signs may be installed on glass because there is no available wall surface. A blank glass back up is then required to be placed on opposite side of glass exactly behind sign being installed.

This section of the Sign and Environmental Graphic Program Guide provides for all the types of interior signs that would be necessary to sign individual buildings to a complete medical center campus or a off site clinic building.

This section is divided into two parts. The first part identifies all room number and identification signs and directional information and the second part covers way-finding, construction, installation and helpful hints.

The following Overview illustrates the various types of signs in this section. The individual pages on each Sign Type provide more specific information and detailed layouts.

Interior Sign Designations

Each sign in the program guide has been give a specific sign type number designation. This designation provide a common description that can be referenced when programming a site and ordering signs. The following explains how the sign type designations are derived.

IN - 03 .01 A

IN Designates an interior sign.

03 Two digit numbers identifies a particular sign type family like the “signs for use in identifying an Ambulance Entrance”.

.01 The two digit number following the period identifies a specific sign within the sign family.

A The letter designates a specific sign configuration, version and/or layout for graphics.

Overview

Interior Signs

IN-03.01

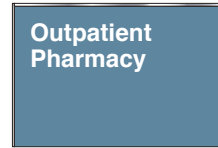
Room Number Identification



IN-03.01

IN-04.01

Primary Room Identification



IN-04.01



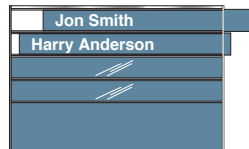
IN-04.02

IN-04.02

Secondary Room Identification

IN-05.01 & .02

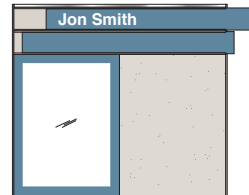
Patient Room Identification



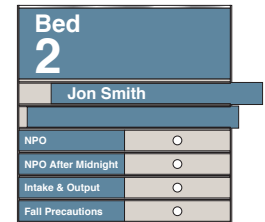
IN-05.01 & .02

IN-05.03 & .04

Patient Room Identification



IN-05.03 & .06



IN-06.01, .02, & .03

IN-06.01, .02 & .03

Patient Bed Sign

IN-07.01, .02 & .03

Conference/Meeting Room Sign



IN-07.01, .02, & .03

IN-08.01, .02, .03 & .04

Prohibit, Instructional & Control Sign



IN-08.01, .02, .03 & .04



IN-09.01, .02, .03, .04, .05, .06 & .07

IN-09.01, .02, .03, .04, .05, .06 & .07

Pictogram & Symbol Sign

IN-09.08, .09

Pictogram & Symbol Sign



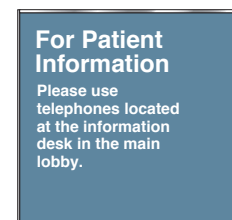
IN-09.08, .09

IN-10.01, .02, .03, .04, .05 & .06

Sign Frame



IN-10.01, .02, .03, .04, .05 & .06



IN-11.01, .02, .03, .04, .05, & .06

IN-11.01, .02, .03 & .04

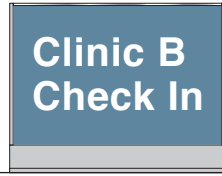
Informational / Instructional Sign

Overview

Interior Signs

IN-12.01, .02, .03 & .04

Desk, Counter Sign



IN-12.01, .02, .03 & .04

IN-13

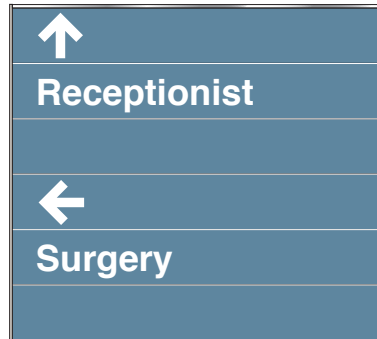
Perpendicular (Flag) Mount Sign



IN-13

IN-14.01, .02, .03, .04 & .05

Wall Directional Sign



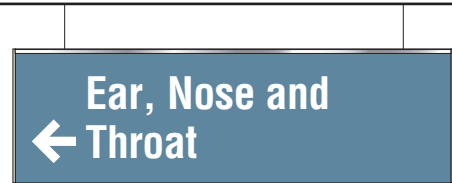
IN-14.01, .02, .03, .04, & .05



IN-14.06

IN-15.01, .02, .03 & .04

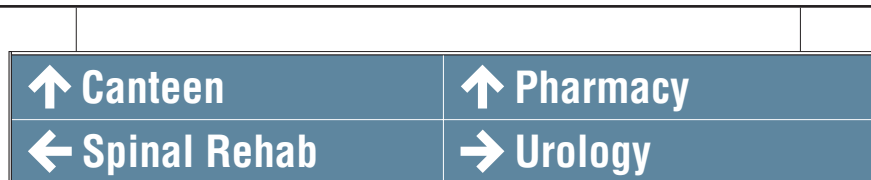
Ceiling Mounted Directional Sign



IN-15.01, .02, .03 & .04

IN-15.05, .06, .07 & .08

Ceiling Mounted Directional Sign



IN-15.05, .06, .07 & .08

IN-15.09, .10, .11 & .12

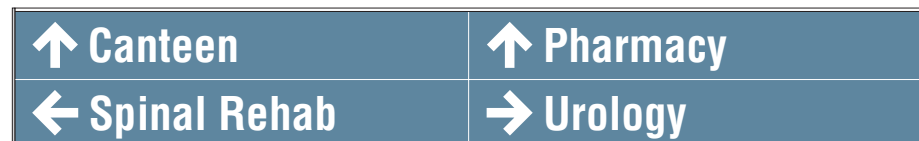
Soffit Mounted Directional Sign



IN-15.09, .10, .11 & .12

IN-15.13, .14, .15 & .16

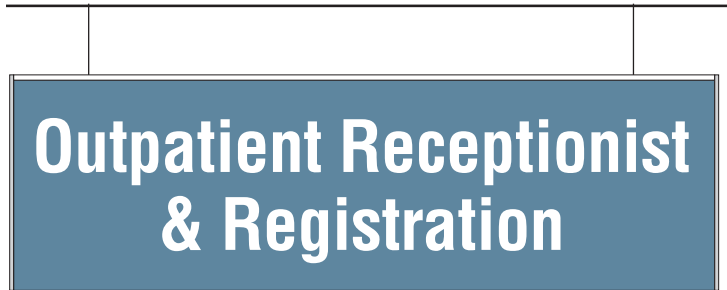
Soffit Mounted Directional Sign



IN-15.13, .14, .15 & .16

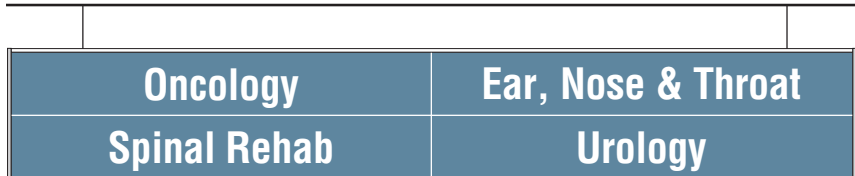
Interior Signs Ê

Ceiling Mounted Directional Sign



IN-16.01, .02, .03 & .04

Ceiling Mounted Directional Sign



IN-16.05, .06, .07 & .08

Soffit Mounted Directional Sign



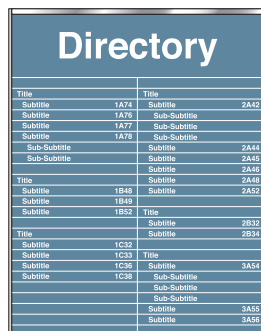
IN-16.09, .10, .11 & .12

Soffit Mounted Directional Sign



IN-16.13, .14, .15 & .16

Directory

**IN-17.01**

Large Directory

**IN-17.02**

Room Number Identification

Size

76 mm H x 229 mm W
(3" H x 9" W)

Description & Use

Sign is to be placed on all rooms that require identification.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Sliding Rail Back; Etched Sign Plaque; Aluminum Top Accent Bar; End Cap

Graphic Process

Tactile room number with accompanying Braille.

Colors

Text: Refer to Color Chart.
Background & Accent Bar: Refer to Color Chart

Type Style

Helvetica Medium
Grade 2 Braille

Mounting

Double sided foam tape, silastic adhesive or screw.

Installation

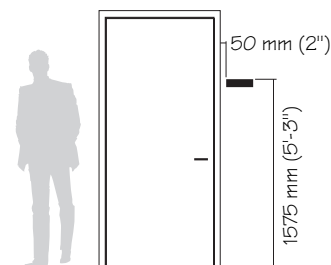
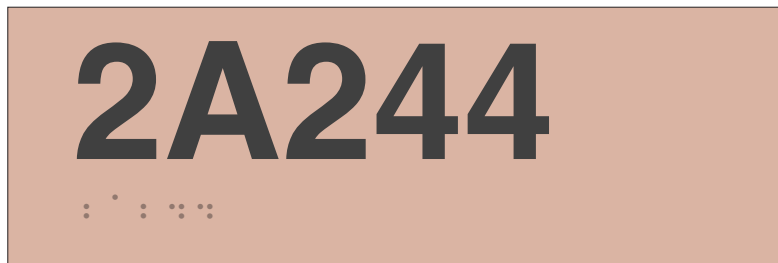
Knob side of door, 1575 mm (63") to top of sign and 50 mm (2") over from door frame.

Recommendations

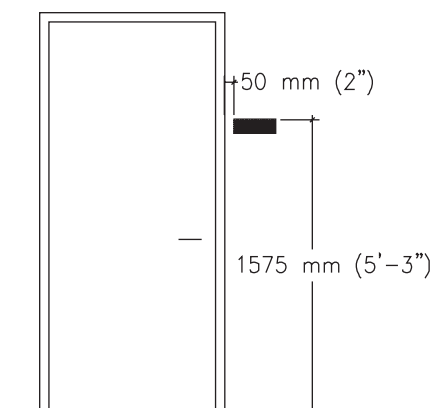
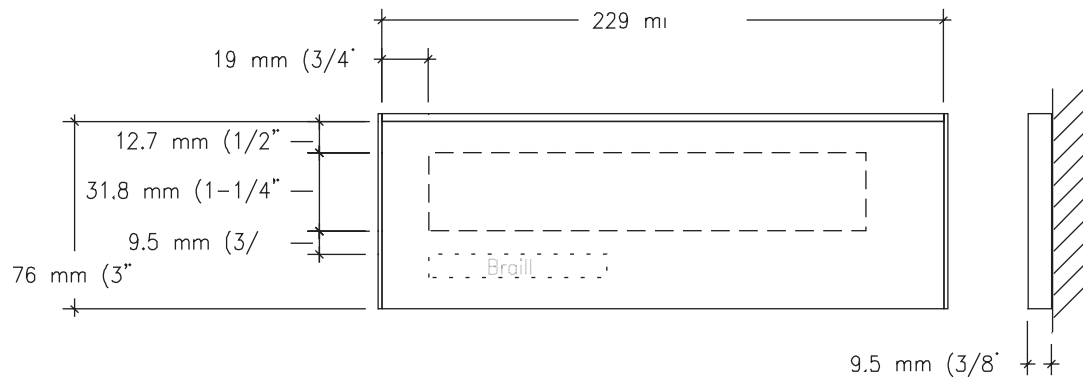
This sign is to be used for all rooms, but can also be used to identify corridors and alcoves as necessary. Do not use on exterior and stairwell doors.



Message Layout A



Room Number Identification



Primary Room Identification

Size

152 mm H x 229 mm W
(6" H x 9" W)

Description & Use

This sign always has a Type IN03 as its top sign component. Use this sign to identify the occupant or activity within a room.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)
Layout A is suggested for department identification. Layout B for rooms and departments with long words or names. Layout C for rooms with a common name but need specific identification.

Sign Components

Sliding Rail Back; Copy Panel;
Accent Bar; End Caps

Graphic Process

Surface applied vinyl.

Colors

Text: Refer to Color Chart.
Background & Accent Bar: Refer to Color Chart

Type Style & Size

Helvetica Medium
Lettering size is adaptable to allow messages to fit on to the sign. Refer to various layouts for reference.

Mounting

Double sided foam tape, silastic adhesive or screw.

Installation

Knob side of door, 1500 mm (60") to top of sign and 50 mm (2") over from door frame.

Recommendations

It is recommended that this particular sign type become the "building standard" for identification of all rooms.

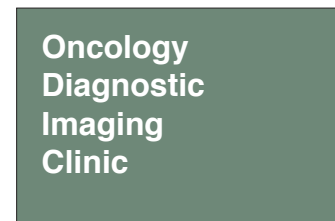
Signs identifying electrical closets, mechanical rooms and telecommunication rooms should consist of only the room number (Sign type IN-03.01). The room number should follow the master building room numbering system. No descriptive name or title should be used nor should they have a unique number system.



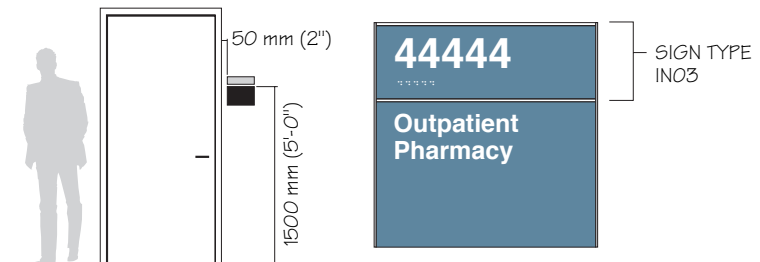
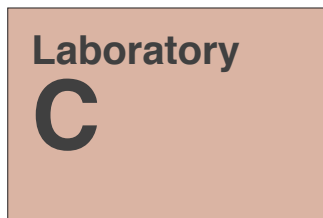
Message Layout A

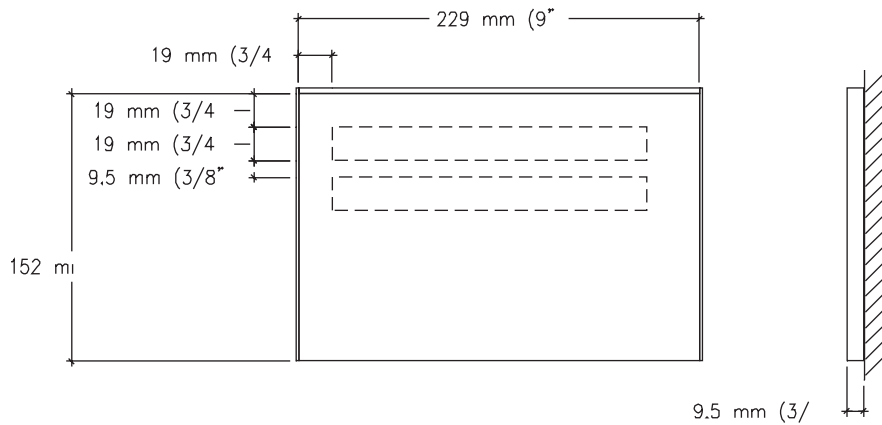


Message Layout B

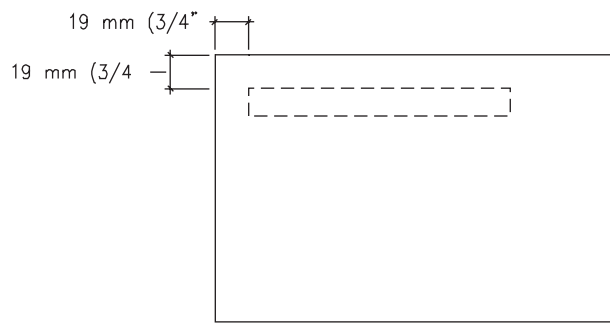


Message Layout C

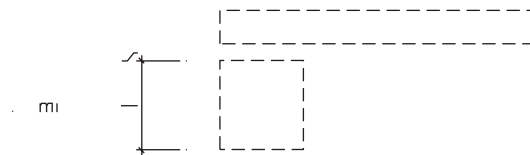




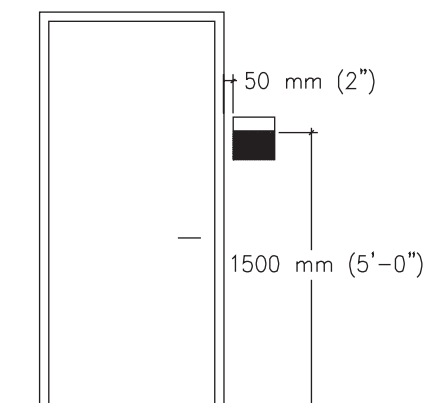
Message Layout A



Message Layout B



Message Layout



Secondary Room Identification

Sign Size

76 mm H x 229 mm W
(3" H x 9" W)

Description & Use

This sign always has a Type 03 as its top sign component. Use this sign to secondary rooms or rooms that have short names.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)
Layout A is suggested for short titles. Layout B is for longer names or titles. Layout C is specific identification by number or letter.

Sign Components

Sliding Rail Back; Copy Panel; Top Accent Bar; End Caps

Graphic Process

Surface applied vinyl.

Colors

Text: Refer to Color Chart.
Background & Accent Bar: Refer to Color Chart

Typography

Helvetica Medium

Mounting

Double sided foam tape, silastic adhesive or screw.

Installation

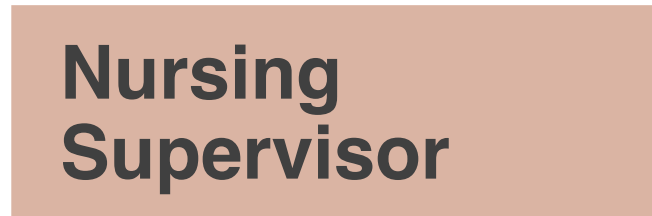
Knob side of door, 1500 mm (60") to top of sign and 50 mm (2") over from door frame.

Recommendations

This sign is for rooms that do not require long or large text.



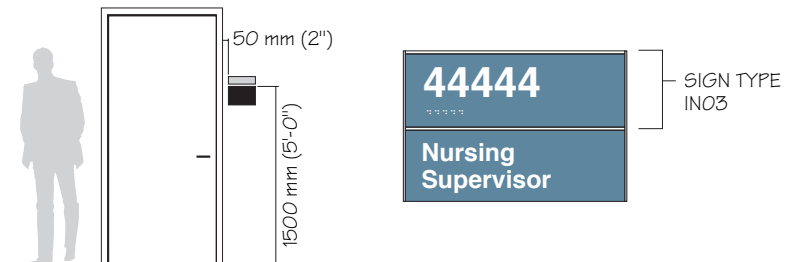
Message Layout A

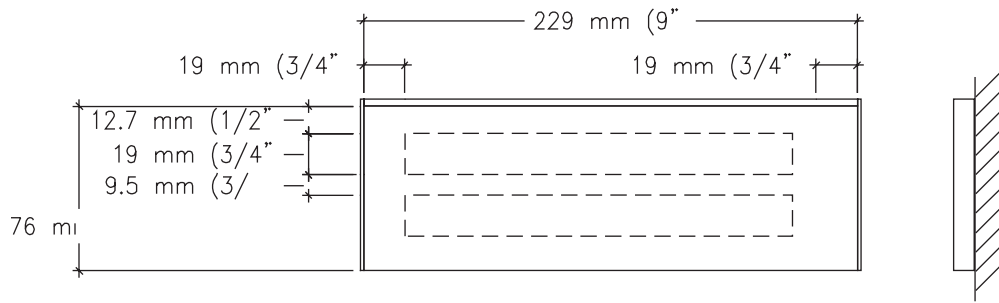


Message Layout B

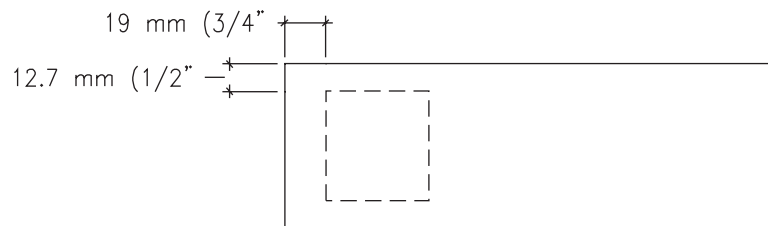
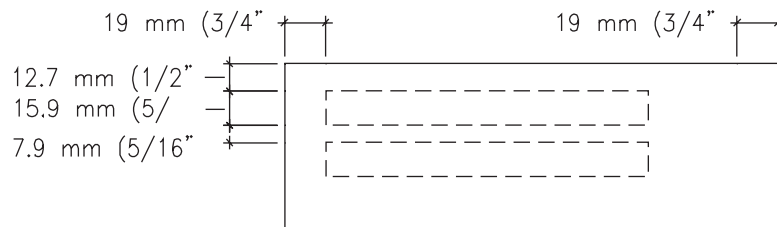


Message Layout C





Message Layout A



Patient Room Identification

Size

IN-05.01
152 mm x 229 mm
(6" x 9")

IN-05.02
76 mm x 229 mm
(3" x 9")

Description & Use

This sign always has a type IN03 as its top component. Use this sign to identify the occupant's of a patient room.

Message Configuration

(Refer to layout drawings for lettering sizes and dimensions)
Paper inserts with patient's names are prepared and removed by each Medical Center based upon occupancy of the room.

Sign Components

Sliding Rail Back; Top Accent Bar;
Polycarbonate Cover; Paper or Film
Copy Insert; Extruded Insert
Holder; Copy Panel; End Caps

Graphic Process

Inserts to be provided by hospital

Colors

Text: Refer to Color Chart.
Background & Accent Bar: Refer to Color Chart

Mounting

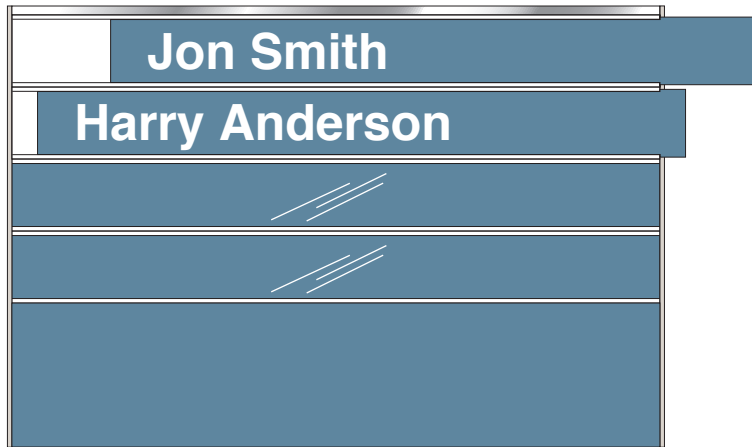
Double sided foam tape, silastic adhesive or screw.

Installation

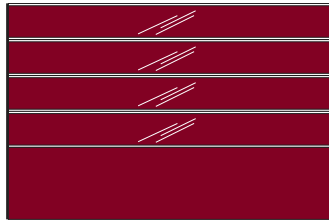
Knob side of door, 1500 mm (60") to top of sign and 50 mm (2") over from door frame.

Recommendations

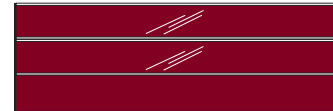
It is recommended that this sign type be used for patient rooms.



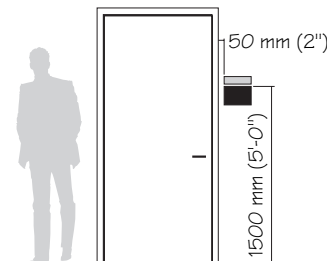
IN-05.01



IN-05.02 Layout A



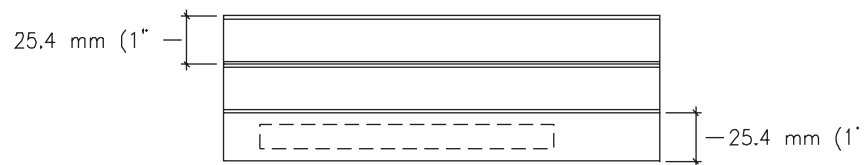
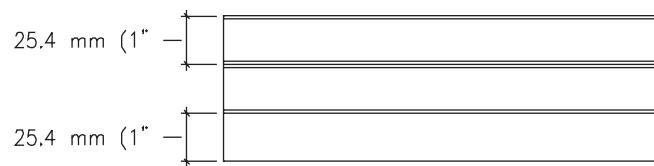
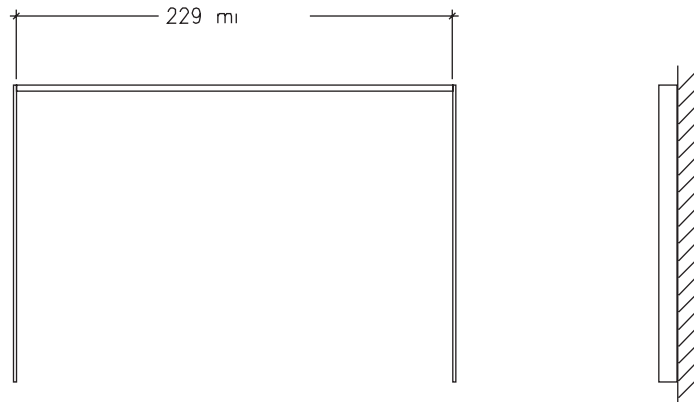
IN-05.02 Layout B



SIGN TYPE IN-03

SIGN TYPE IN-22.01

Patient Room Identification



Size

IN-05.03
330 mm x 305 mm
(1' 1" x 1' 0")

IN-05.05
330 mm x 610 mm
(1' 1" x 2' 0")

Description & Use

This sign always has a type IN03 as its top component. Use this sign to identify the occupant's of a nursing home patient room. Window receives a 4" x 6" photo of the patient which is provided by the facility. The adjacent component is a tack surface for mounting memorabilia.

Message Configuration

(Refer to layout drawings for lettering sizes and dimensions)
Paper inserts with patient's names are prepared and removed by each Medical Center based upon occupancy of the room.

Sign Components

Sliding Rail Back; Top Accent Bar;
Polycarbonate Cover; Paper or
Film
Copy Insert; Extruded Insert
Holder; Copy Panel; End Caps

Graphic Process

Inserts to be provided by hospital

Colors

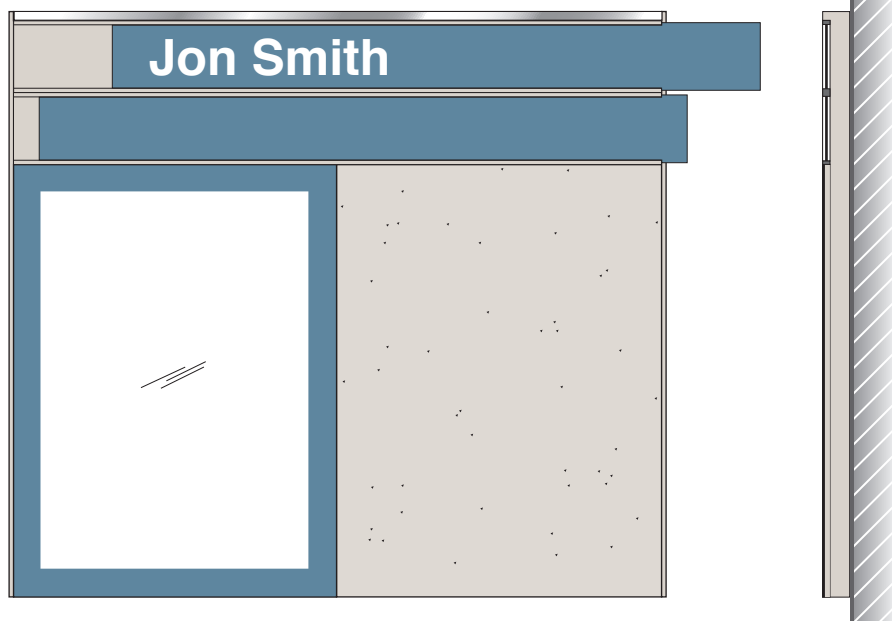
Text: Refer to Color Chart.
Background & Accent Bar: Refer to
Color Chart

Mounting

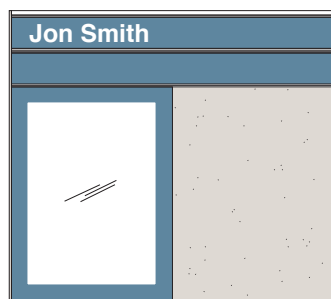
Double sided foam tape, silastic
adhesive or screw.

Installation

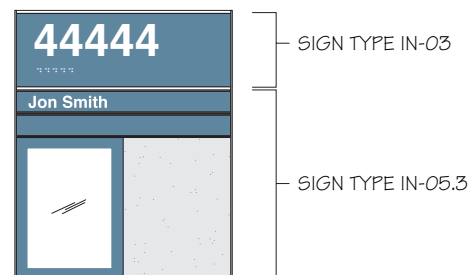
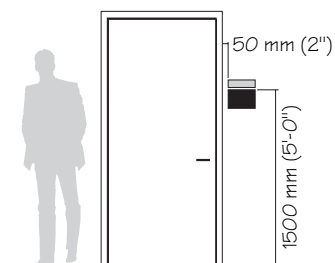
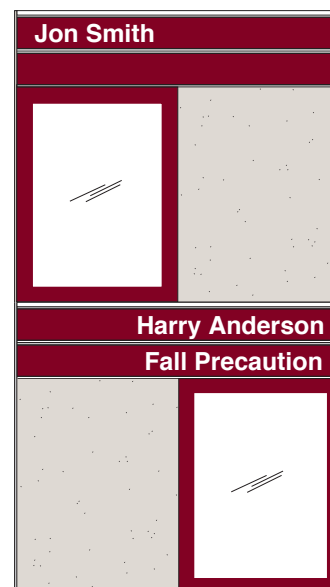
Knob side of door, 1500 mm (60")
to top of sign and 50 mm (2") over
from door frame.



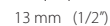
IN-05.03



IN-05.05



Patient Room Identification



Patient Bed Sign

Size

IN-06.01
127 mm x 229 mm
(5" x 9")

IN-06.02
229 mm x 229 mm
(9" x 9")

IN-06.03
279 mm x 229 mm
(11" x 9")

Description & Use

Use this sign above patient beds to identify the bed and the patient.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)
Insert names are prepared and removed based upon occupancy of the room. Selection of the text to appear behind the slider is to be selected by nursing at a medical center, based on their particular needs.

Sign Components

Sliding Rail Back; Polycarbonate Cover, Extruded Insert Holder, Paper or Film Copy Insert, Slider; Top Accent Bar; End Caps

Graphic Process

Vinyl text.
Name inserts provided by hospital.
Text behind slider is second surface applied.

Colors

Text: Refer to Color Chart.
Background & Accent Bar: Refer to Color Chart

Typography

Helvetica Medium

Mounting

Double sided foam tape, silastic adhesive or screw.

Installation

On headwall above bed.

Recommendations

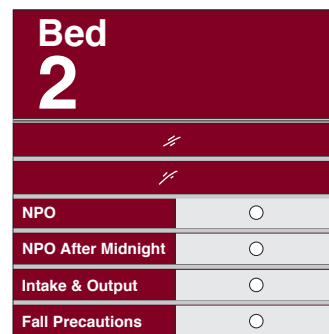
This sign is for use in patient rooms and is to be coordinated with the needs and function with nursing services.



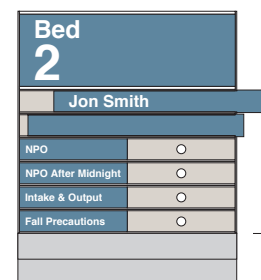
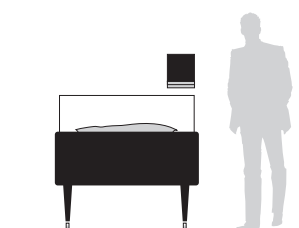
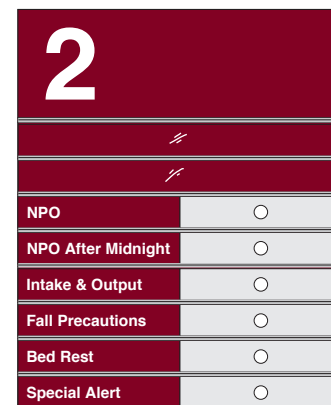
IN-06.01



IN-06.02

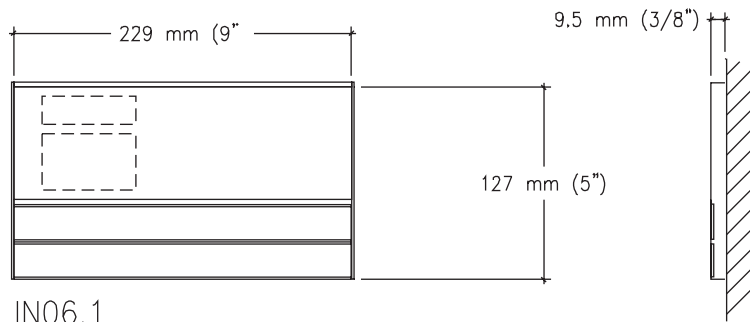


IN-06.03

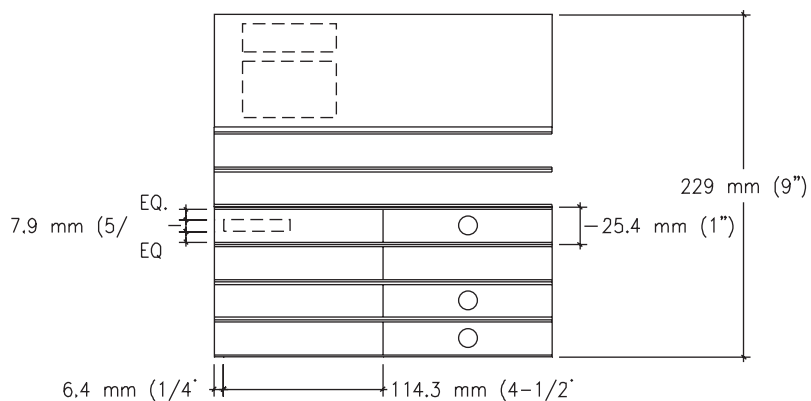


SIGN TYPE IN22.1

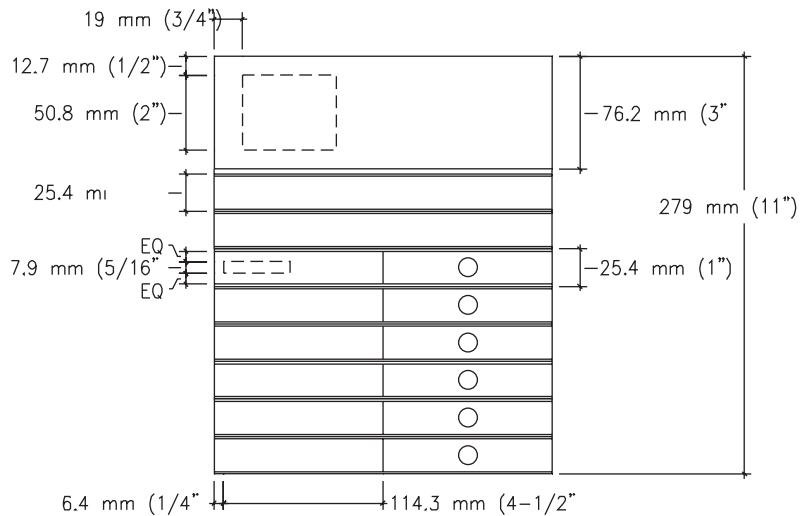
Patient Bed Sign



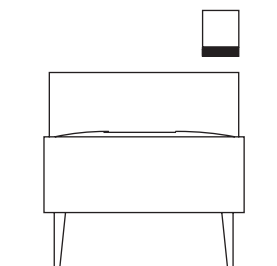
IN06.1



IN06.2



IN06.3



IN-07.01-3

Interior Signs Ê

Conference / Meeting Room Sign

Size

Sign Size

IN-07.01

152 mm x 229 mm
(6" x 9")

IN-07.02

76 mm x 229 mm
(3" x 9")

IN-07.03

152 mm x 229 mm
(6" x 9")

Description & Use

This sign always has a Type 03 as its top sign component. Use this sign for conference rooms, meeting rooms. This type of sign can also be used for exam rooms, treatment rooms, and offices where the occupants may be conducting patient interviews.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)
IN07.1, Layout A is for conference rooms, Layout B is for exam or treatment rooms. N07.3 Insert messages are prepared and removed based upon occupancy of the room. Selection of the text to appear behind the slider is to be determined by the medical center.

Sign Components

Sliding Rail Back; Polycarbonate Cover, Extruded Insert Holder, Paper or Film Copy Insert, Slider; Top Accent Bar; End Caps

Graphic Process

Surface applied vinyl. IN07.3 name inserts provided by hospital. Text behind slider is second surface.

Colors

Text: Refer to Color Chart.
Background & Accent Bar: Refer to Color Chart

Typography

Helvetica Medium

Mounting

Double sided foam tape, silastic adhesive or screw.

Installation

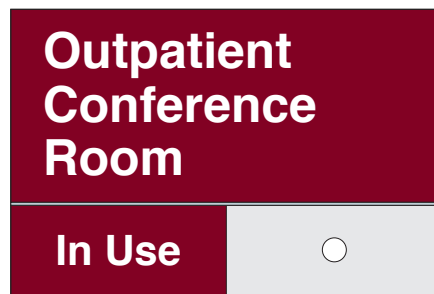
Knob side of door, 1500 mm (60") to top of sign and 50 mm (2") over from door frame.

Recommendations

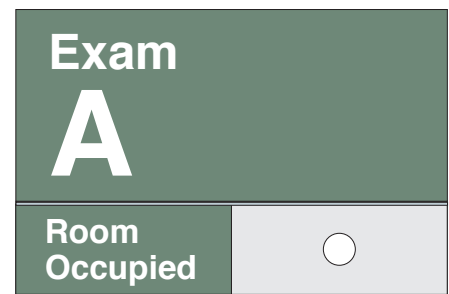
This sign is for use on rooms where an indication is needed in the hallway that the room is occupied or an activity is taking place in the room which should not be disturbed.



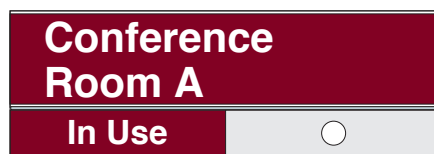
IN-07.01 (Message Layout A)



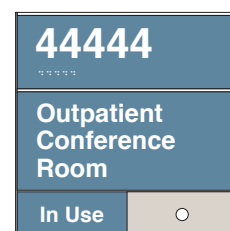
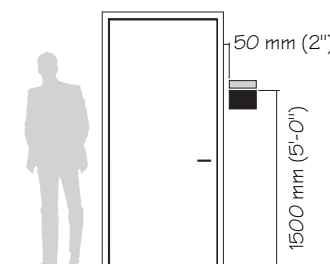
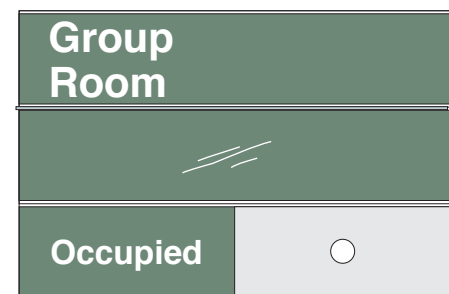
IN-07.01 (Message Layout B)



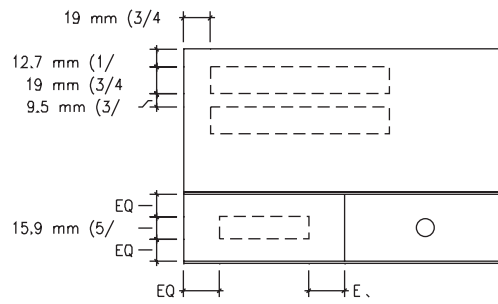
IN-07.02



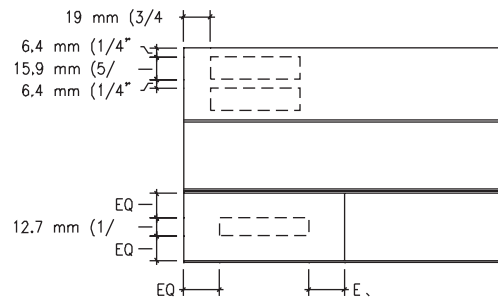
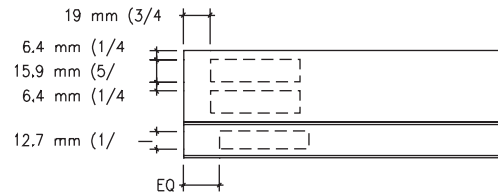
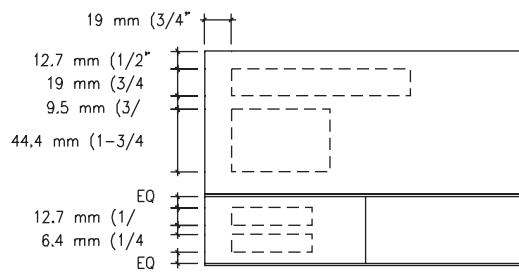
IN-07.03



SIGN TYPE IN-03



IN07.1 (Layout A)



Size

229 mm H x 229 mm W
(9" H x 9" W)

Description & Use

Use these signs to inform in a bold manner.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Acrylic plaque.

Graphic Process

Silk-screened or surface applied vinyl.

Colors

Text: Refer to Color Chart.

Symbol: Red - B3 and White - T1

Background : Refer to Color Chart

Typography

Helvetica Medium

Mounting

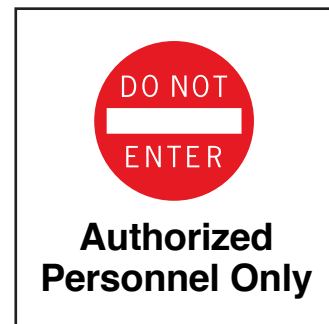
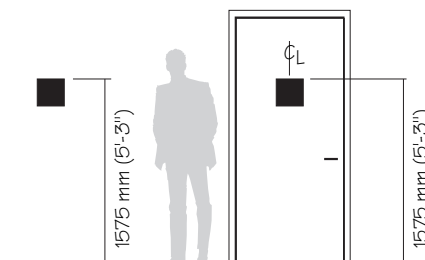
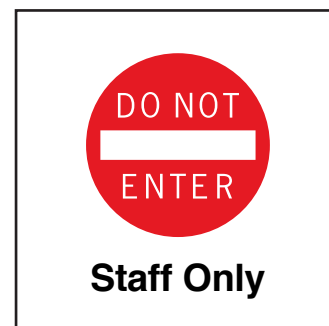
Double sided foam tape or silastic adhesive.

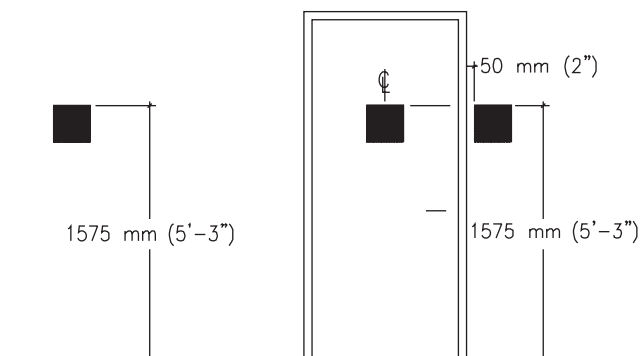
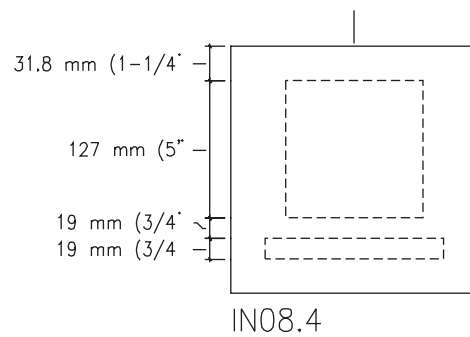
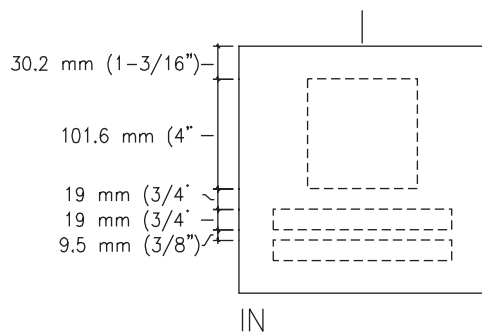
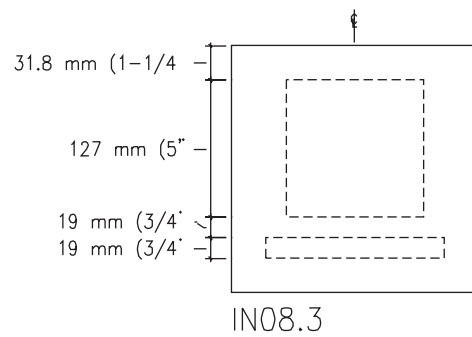
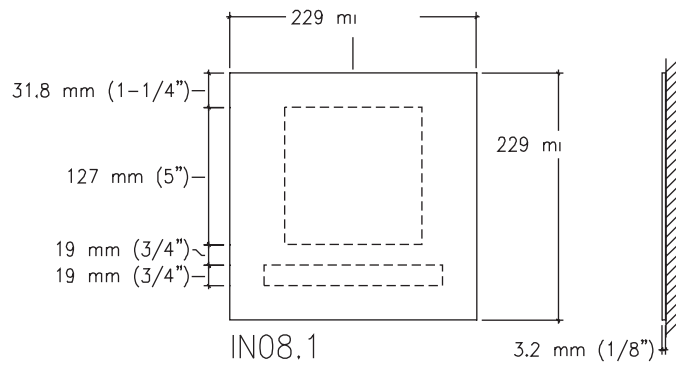
Installation

On wall or door 1575 mm (63") to top of sign and on door, center.

Recommendations

This sign is for use when a strong communication of information is necessary. IN08.4 should be used carefully as it may have a negative reaction on the part of patients and visitors.

**IN-08.01****IN-08.02****IN-08.03****IN-08.04**



IN-09.01-7

Interior Signs Ê

Pictogram & Symbol Signs

Size

229 mm H x 229 mm W
(9" H x 9" W)

Description & Use

Use these signs to inform with a symbol as well as text.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Etched sign plaque face laminated to acrylic backing plaque.

Graphic Process

Tactile symbol and text with accompanying Braille.

Colors

Text: Refer to Color Chart.
Background & Accent Bar: Refer to Color Chart

Typography

Helvetica Medium
Grade 2 Braille

Mounting

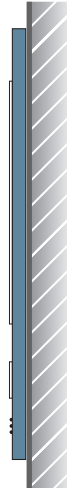
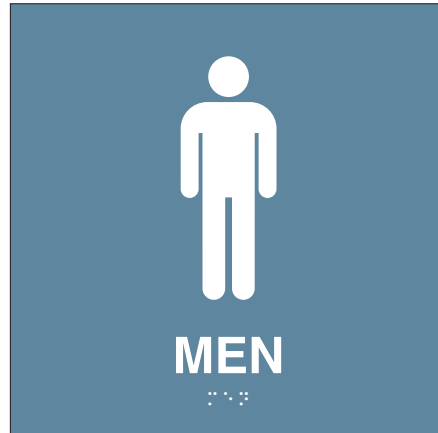
Double sided foam tape or silastic adhesive.

Installation

On wall or door 1575 mm (63") to top of sign and on door, center.

Recommendations

These signs are for use on restrooms or stair doors or under a Type IN-03 sign.



IN-09.01



IN-09.02



IN-09.03



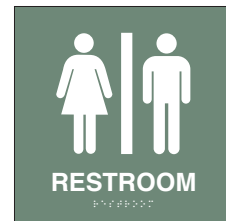
IN-09.04



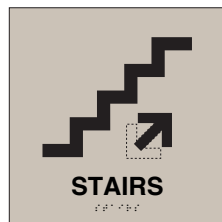
IN-09.05



IN-09.06



IN-09.07

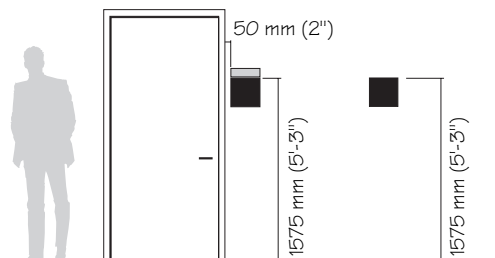
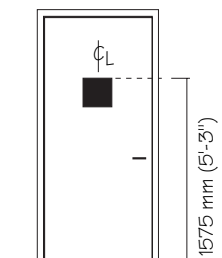


IN-03

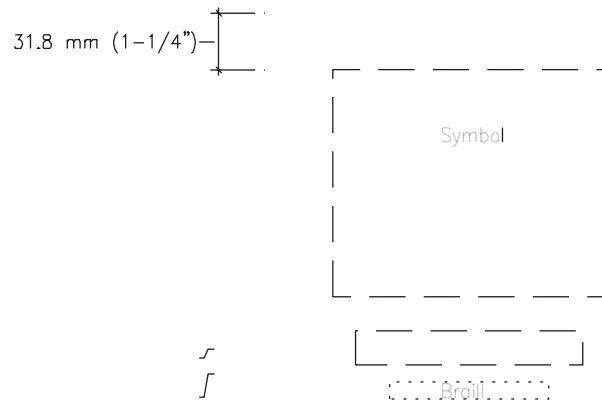
IN-09.06



Door mounted



Wall mounted



IN09.1

IN09.2

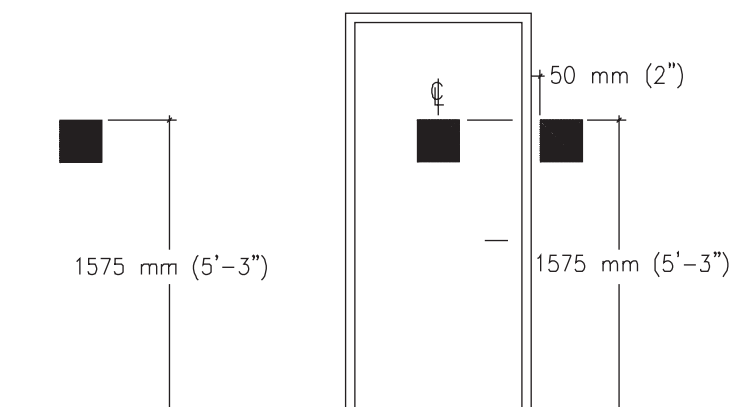
IN09.3

IN09.4

IN09.5

IN09.6

IN09.7



Pictogram & Symbol Signs

Size

229 mm H x 229 mm W
(9" H x 9" W)

Description & Use

Use these signs to inform with a symbol as well as text.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Acrylic plaque.

Graphic Process

Silk-screened or surface applied vinyl.

Colors

Text: Refer to Color Chart.
Background & Accent Bar: Refer to Color Chart

Typography

Helvetica Medium

Mounting

Double sided foam tape or silastic adhesive.

Installation

On wall or door 1575 mm (63") to top of sign and on door, center.

Recommendations

These signs are for use when a symbol will help communicate.



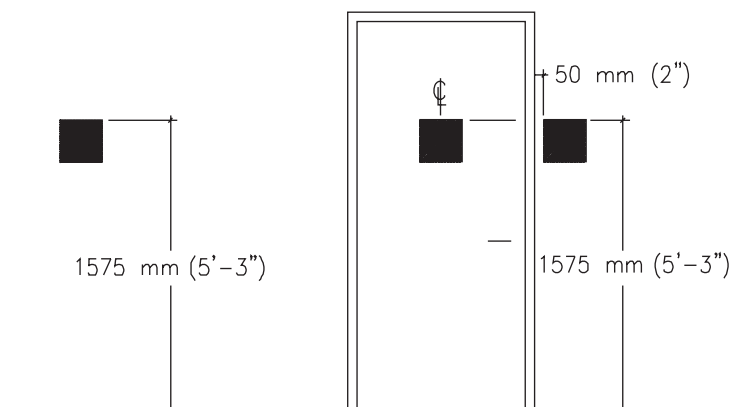
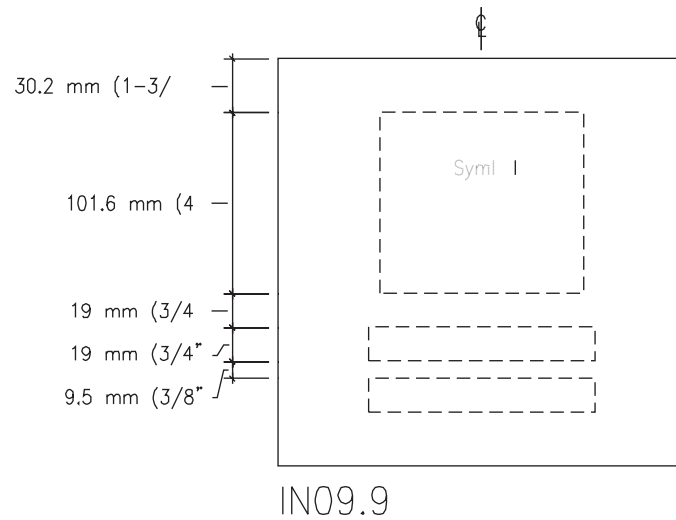
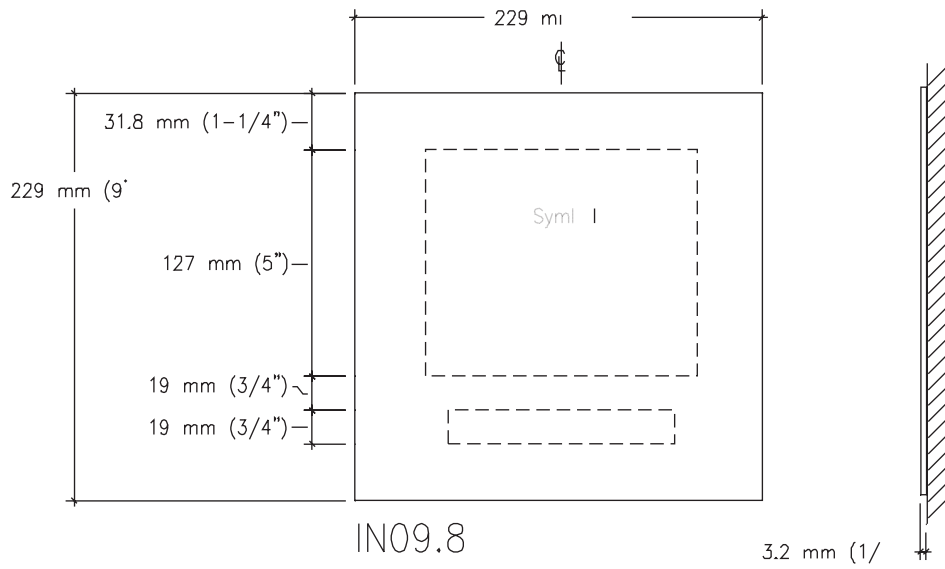
IN-09.08



IN-09.09



Pictogram & Symbol Signs



Sign Frame

Size

IN-10.02
547 mm x 407 mm
(21 1/2" x 16")

IN-10.03
457 mm x 305 mm
(18" x 12")

IN-10.04
305 mm x 457 mm
(12" x 18")

IN-10.05
305 mm x 242 mm
(12" x 9 1/2")

IN-10.06
242 mm x 305 mm
(9 1/2" x 12")

Description & Use

Use these signs to hold posters, fire alarm bell schedules, maps or other information sheets.

10.2 14" x 20" paper poster
10.3 11" x 17" paper, vertical
10.4 11" x 17" paper,

horizontal

10.5 8 1/2" x 11" paper, vertical

10.6 8 1/2" x 11" paper, horizontal

Sign Components

Acrylic plaque.

Colors

Text: Refer to Color Chart.
Background & Accent Bar: Refer to Color Chart

Mounting

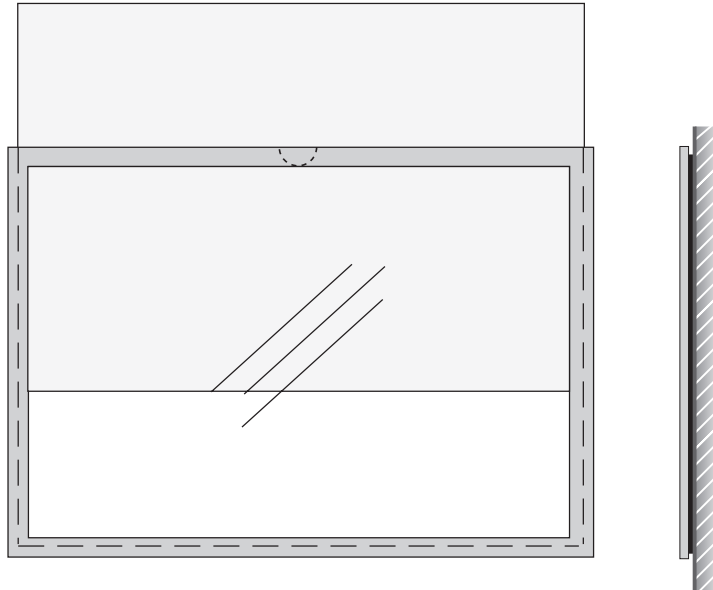
Double sided foam tape or silastic adhesive.

Installation

On wall

Recommendations

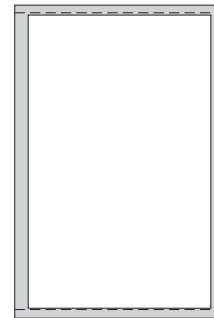
These signs are for use to hold papers and posters vertically or horizontally.



IN-10.02



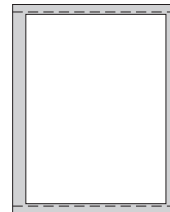
IN-10.03



IN-10.04



IN-10.05



IN-10.06



IN-10.04
IN-10.05
IN-10.06

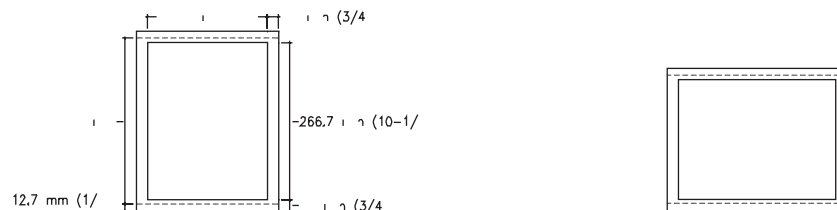
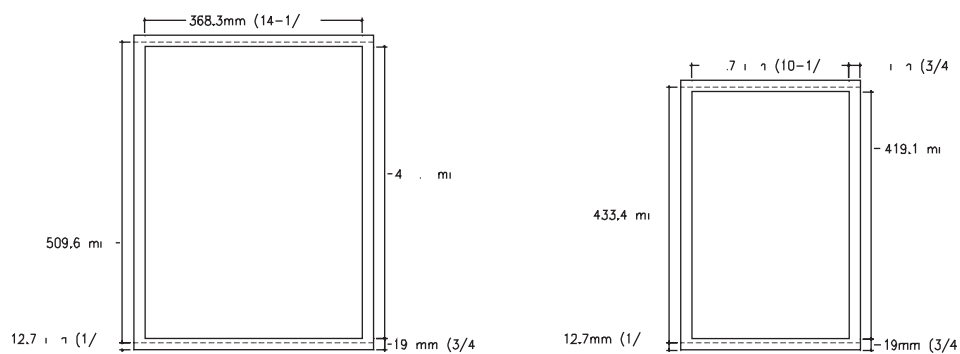
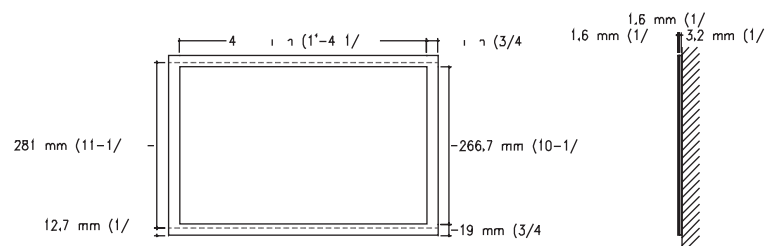
1500 mm (5'-0")

IN-10.02
IN-10.03

1650 mm (5'-6")



Sign Frame



Size

IN-11.01
229 mm x 229 mm
(9" x 9")

IN-11.02
381 mm x 381 mm
(15" x 15")

IN-11.03
508 mm x 508 mm
(20" x 20")

IN-11.04
152 mm H x 152 mm W
(6" H x 6" W)

Description & Use

Use this sign to communicate miscellaneous information.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)
Layouts relate to the size and importance of message.

Sign Components

Sliding Rail Back; Copy Panel; Top Accent Bar; End Caps

Graphic Process

Surface applied vinyl.

Colors

Text: Refer to Color Chart.
Background & Accent Bar: Refer to Color Chart

Typography

Helvetica Medium

Mounting

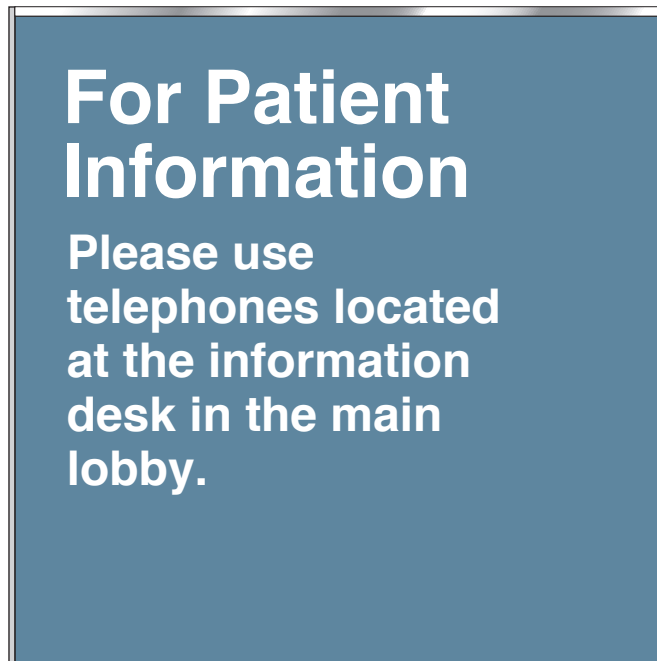
Double sided foam tape, silastic adhesive or screw.

Installation

On wall

Recommendations

These sign are for use to present brief general messages. Text should be limited to as few a words as possible. Long messages are generally not read.



IN-11.01

For Your Information
Ojnf naleotj nalihiie
akindia majroopa.
Halweo nahia aneio
sojoja marjap naohr
asoow.

IN-11.04

For Your Information
Ojnf naleotj nalihiie
akindia majroopa.
Halweo nahia aneio
sojoja marjap naohr
asoow.

IN-11.02

For Your Information

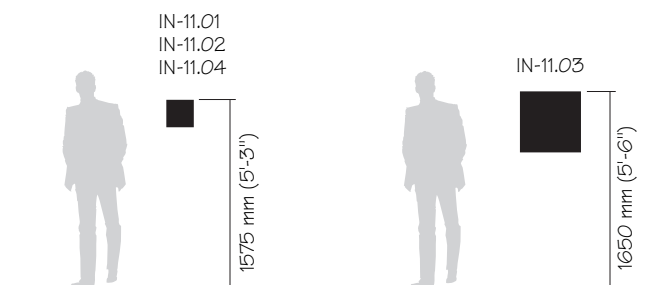
Fraerfej nongini niomgi ni usdhon
aoingonio rij n. Gaoehr diohionn;dn
jfa'opwej ojioan au ef esij ej kanfii
ohaoifhan. HAOuhef feihfiia0t0
sijji. Hajkseh ioawul abshrioa.
IAhowrhihi suhfeu aihof ainta
aojwo abwirioogs. Kajwhr kkigo
aihwaoho. Jlaofn elijaj amwirja
awnapi anwkorjopa.

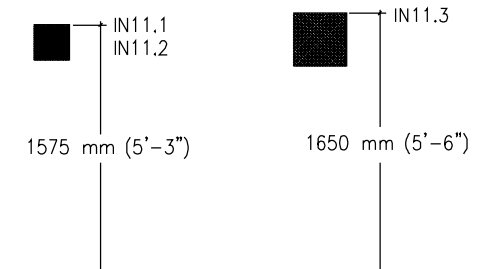
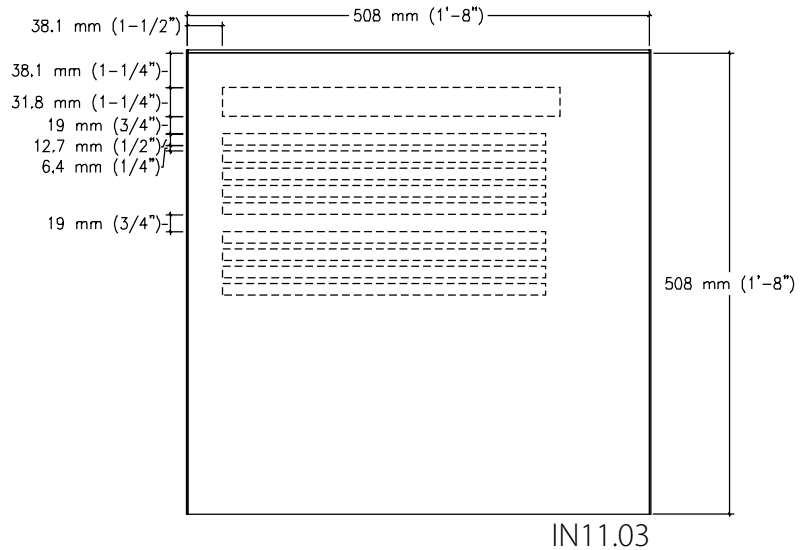
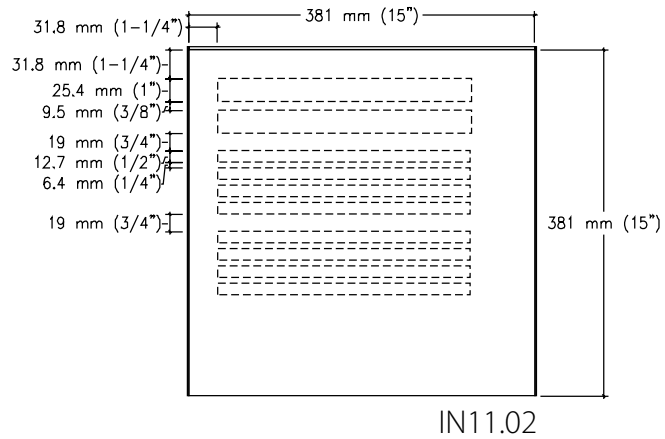
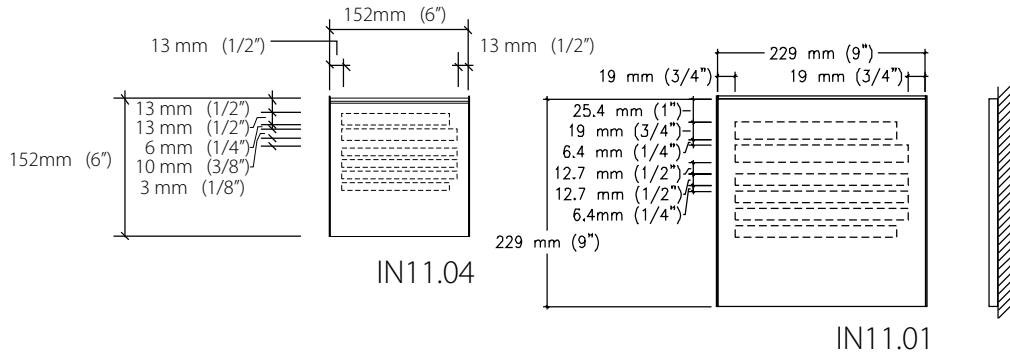
IN-11.03

Be Informed

Lakeiea nahel naciw anowh amwirj ajshr
aiwirioan. Bakwoa iehaoi ksw aw
ejfaj naowurth eian. Amakej airhaoinfiao fnia
aiefioa naiv aie aieh. O aoh aebfaui naie
aiehaioh ahiw awioh erapont aheioa aniowa
awhaioh hai aw9u awiohroahia.

Si usted es un paciente que está recibiendo tratamiento por cualquier forma de cáncer de la prostate, o antes de comenzar a recibir una dosis para cáncer de la prostate, se le urge a su médico a consultar que la que un número exacto de medidas alternativas de tratamiento eficaz, según la Sección 1794.7 del Código de Salud y Seguridad de California.





Desk, Counter Sign

Size

IN-12.01

152 mm x 229 mm
(6" x 9")

IN-12.02

229 mm x 229 mm
(9" x 9")

IN-12.03-04

76 mm x 229 mm
(3" x 9")

Description & Use

Use this sign for messages to be communicated at counters and desks.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)
IN12.1 is for titles or titles with a short informational text. IN12.2 is for long titles or titles with a long informational text. IN12.3 is suggested for use as a desk plaque with and individuals name.

Sign Components

Sliding Rail Back; Copy Panel; Top Accent Bar; End Caps, Extruded Aluminum Mounting Bracket

Graphic Process

Surface applied vinyl.

Colors

Text: Refer to Color Chart.
Background & Accent Bar: Refer to Color Chart

Typography

Helvetica Medium

Mounting

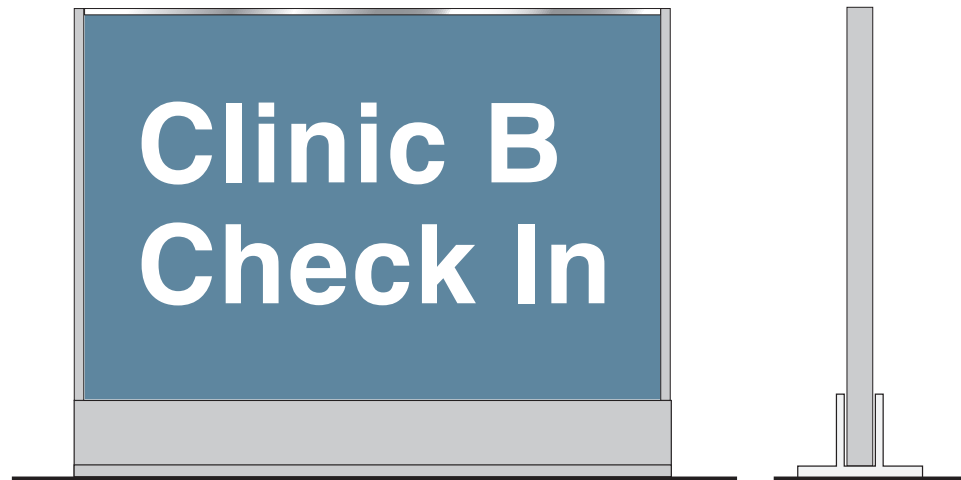
Freestanding.

Installation

On counter or desk.

Recommendations

This sign is for use if information does not require long or large text and needs to be removed or relocated based on the function of the counter.



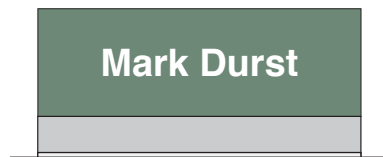
IN-12.01



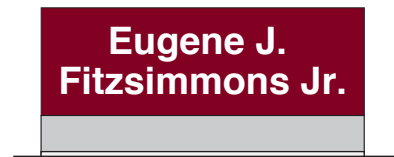
IN-12.02

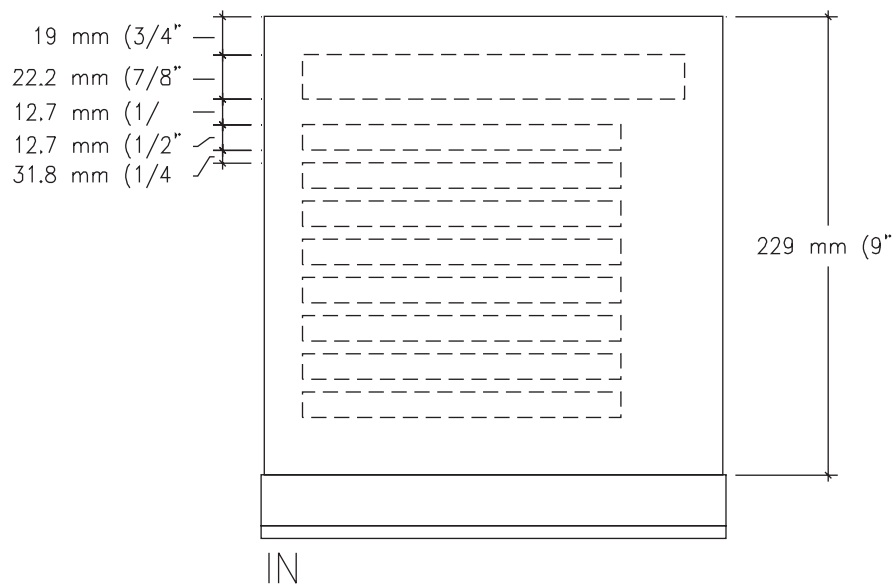
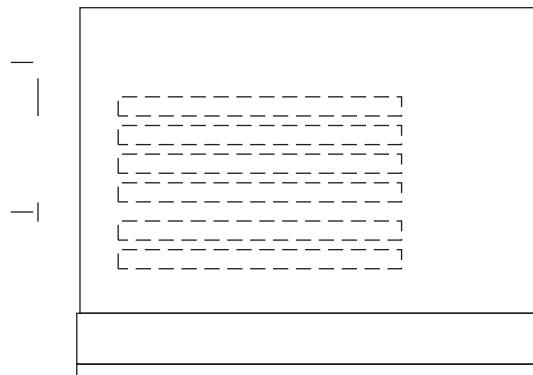


IN-12.03

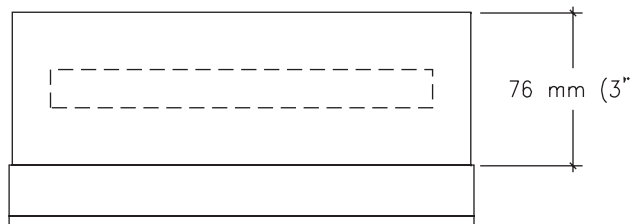


IN-12.04





IN



Size

229 mm H x 305 mm W
(9" H x 12" W)

Description & Use

Use this sign for messages to be communicated in corridors on the wall, above doors.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)
Layout A is for symbols and title / informational text. Layout B is for directional information. Layout C is for a department name.

Sign Components

Sliding Rail Back; Copy Panel; Top Accent Bar; End Caps, Extruded Aluminum Bracket

Graphic Process

Surface applied vinyl.

Colors

Text & Symbols: Refer to Color Chart.
Background & Accent Bar: Refer to Color Chart

Typography

Helvetica Medium Condensed

Mounting

Wall mount with screws.

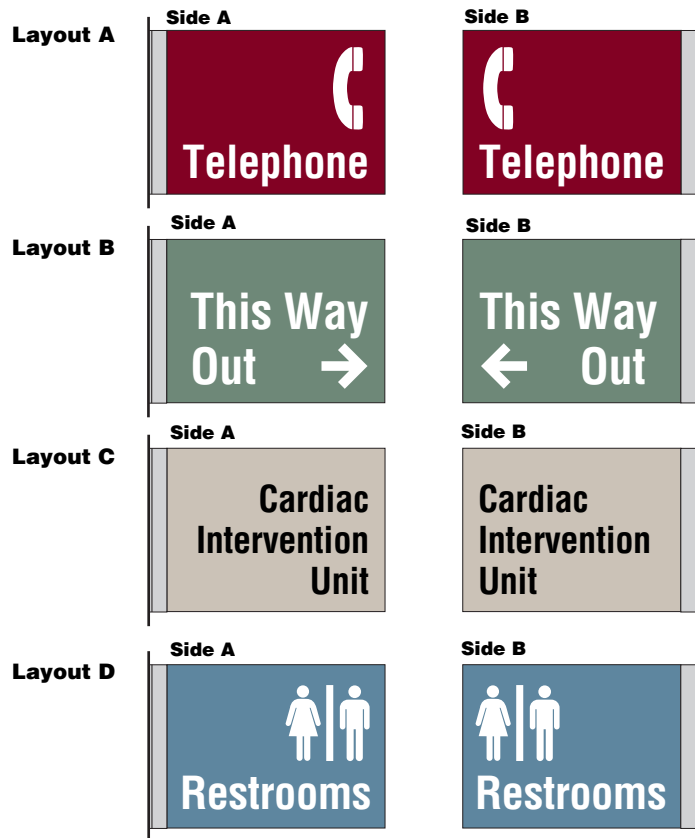
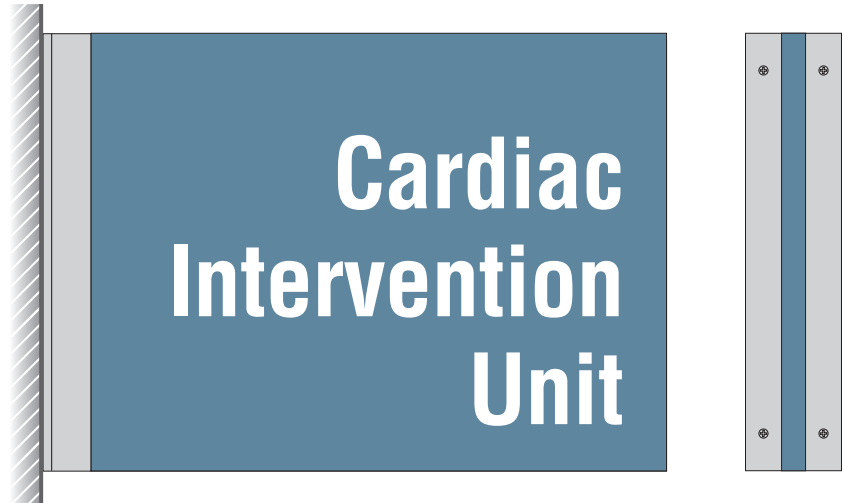
Installation

Install on wall above the height of doors, 2100 mm (84") minimum to bottom of sign.

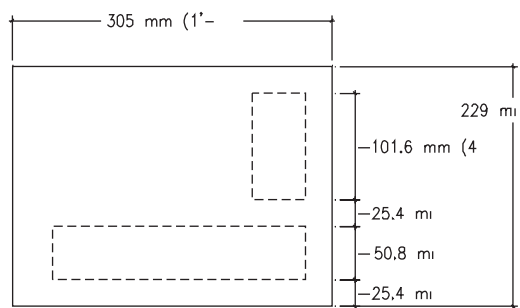
Recommendations

This sign is for use when the service or department is a high traffic area or the service or department is hard to find.

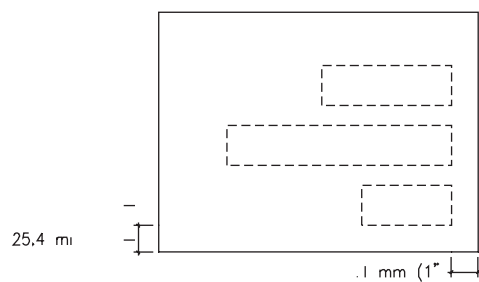
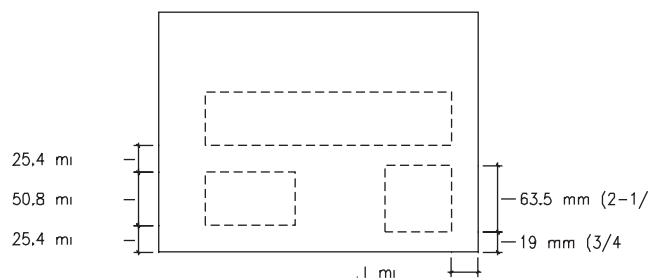
Perpendicular (Flag) Mount Sign



Perpendicular (Flag) Mount Sign



ayout A



IN-14.01-5

Interior Signs Ê

Wall Directional Sign

Size

IN-14.01
610 mm x 508 mm
(24" x 20")

IN-14.02
762 mm x 508 mm
(30" x 20")

IN-14.03
914 mm x 508 mm
(36" x 20")

IN-14.04
457 mm x 508 mm
(18" x 20")

IN-14.05
305 mm x 508 mm
(12" x 20")

Sign Use & Application

Use this sign for directional information.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Sliding Rail Back; Copy Panel; Top Accent Bar; End Caps

Graphic Process

Surface applied vinyl.

Colors

Text & Arrows: Refer to Color Chart.
Background & Accent Bar: Refer to Color Chart

Typography

Helvetica Medium

Mounting

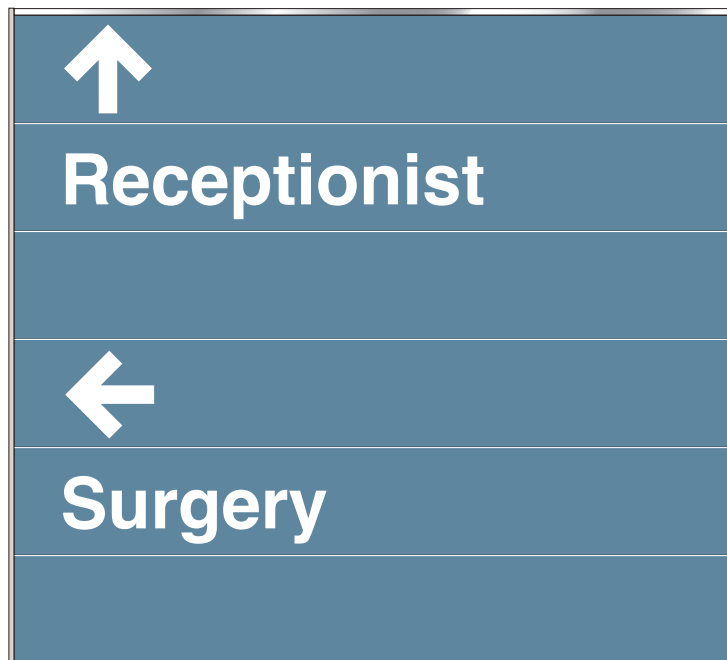
Double sided foam tape, silastic adhesive or screw.

Installation

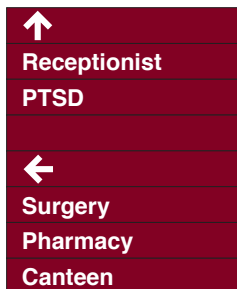
On wall.

Recommendations

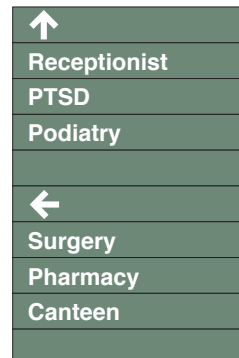
This sign is for use in corridors to direct patients and public through the building.



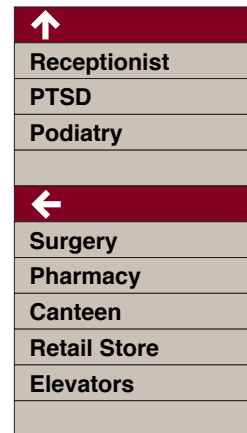
IN-14.01



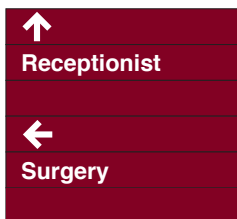
IN-14.02



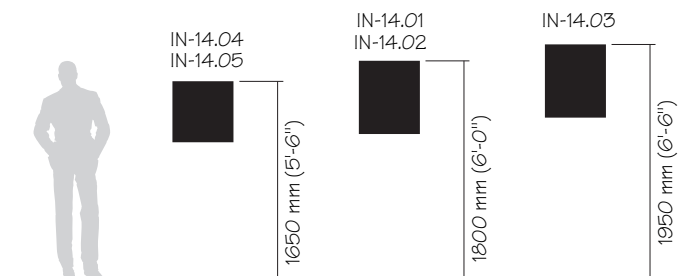
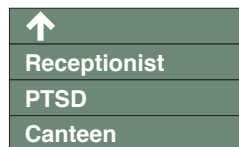
IN-14.03



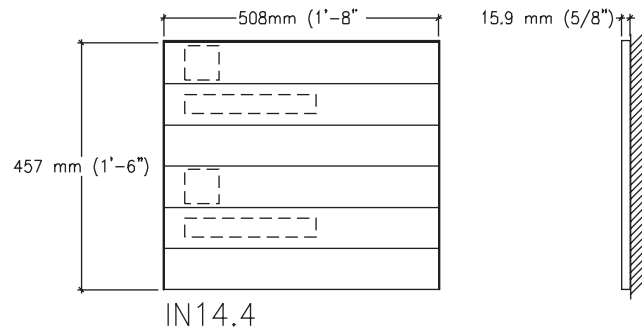
IN-14.04



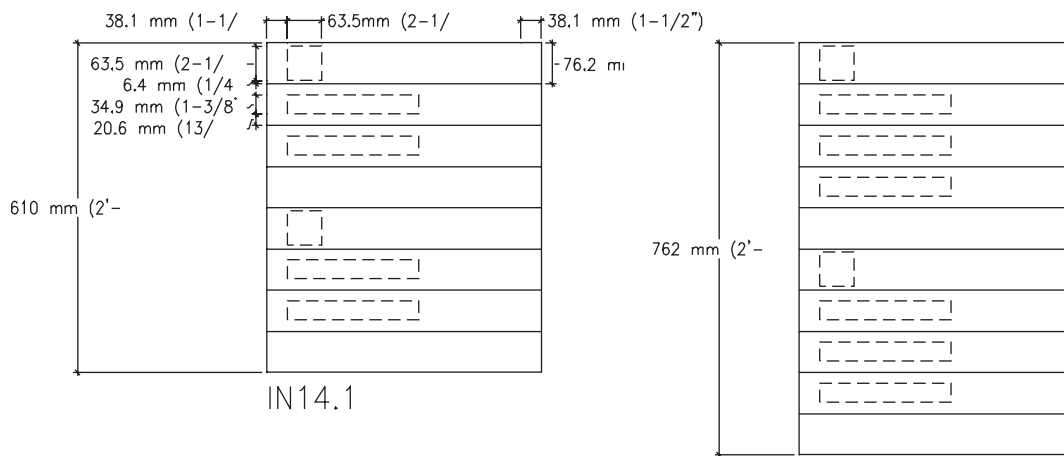
IN-14.05



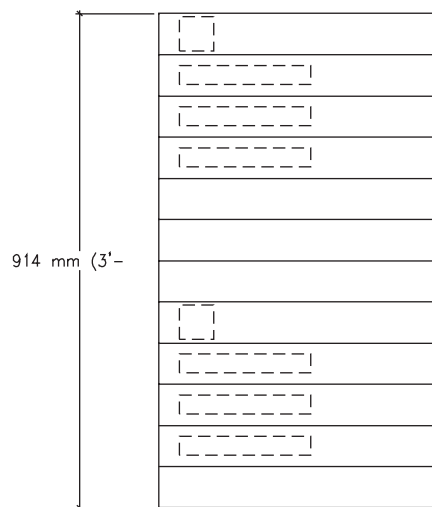
Wall Directional Sign



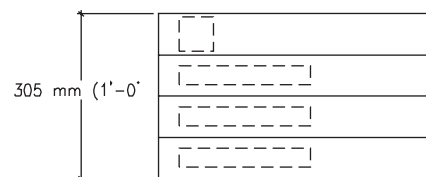
IN14.4



IN14.2

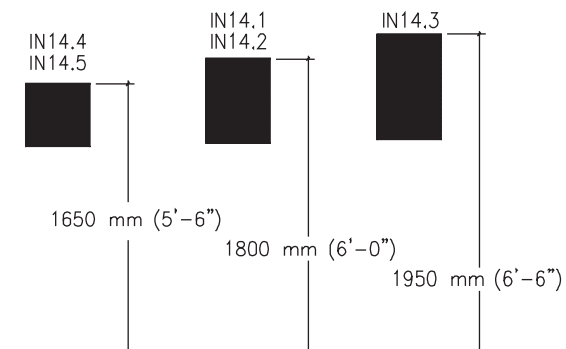


IN14.3



IN14.5

ARROW: R - u -
 andar l - r arrow
 positioning rel iriv -
 ux .



IN-14.06

Interior Signs Ê

Elevator Lobby Directional Sign

Size

229 mm H x 508 mm W
(9" H x 20" W)

Description & Use

Use this sign for directional information in a elevator lobby or stairwell landing. This sign is always a top sign component to a Type 14 sign.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Sliding Rail Back; Copy Panel; Top Accent Bar; End Caps

Graphic Process

Surface applied vinyl.

Colors

Text: Refer to Color Chart.
Background & Accent Bar: Refer to Color Chart

Typography

Helvetica Medium

Mounting

Double sided foam tape, silastic adhesive or screw.

Installation

On wall.

Recommendations

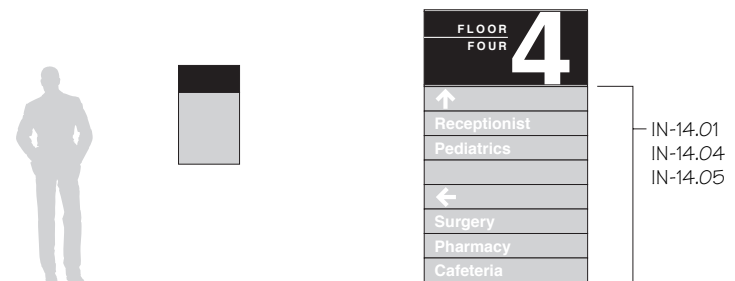
Use in elevator lobbies, across from the elevators, to direct patients and public. Use at stair landings, across from the door to direct patients and public.



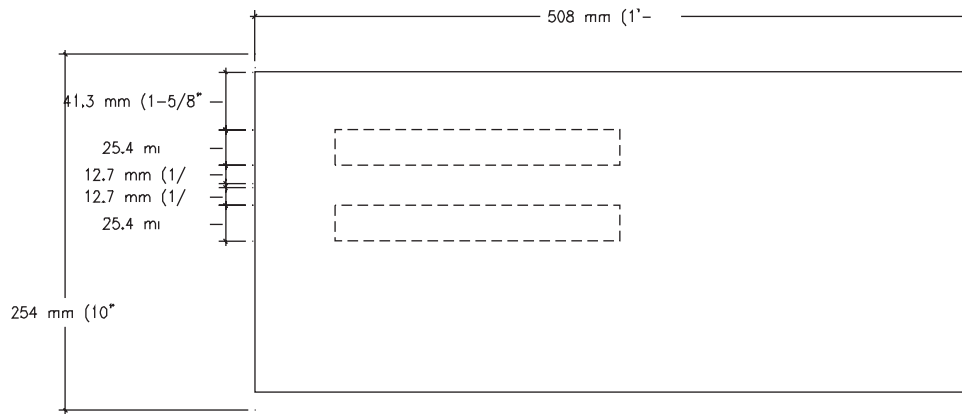
Message Layout A



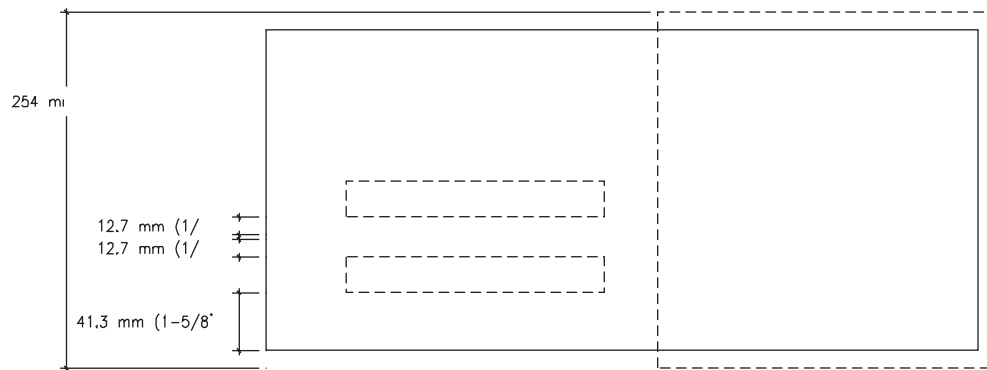
Message Layout B



Elevator Lobby Directional Sign



Message Layout A



IN-15.01-4

Interior Signs Ê

Size

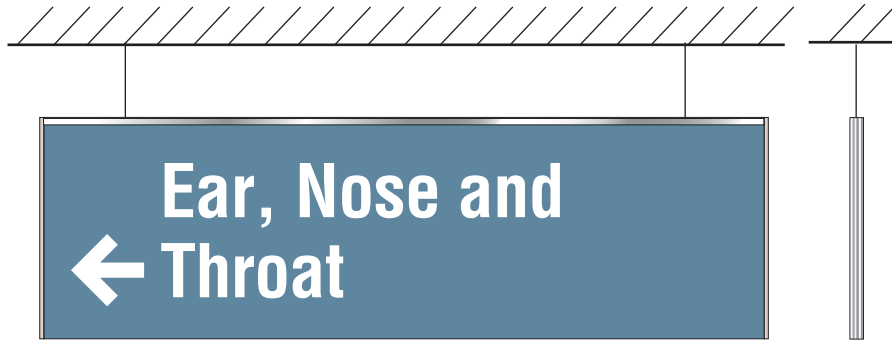
IN-15.01
152 mm x 1016 mm
(6" x 40")

IN-15.02
305 mm x 1016 mm
(12" x 40")

IN-15.03
457 mm x 1016 mm
(18" x 40")

IN-15.04
305 mm x 1016 mm
(12" x 40")

Ceiling Mounted Directional Sign



Description & Use

Use this sign for directional information that needs to be communicated overhead. Sign is double sided and both sides can be used for messages.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Sliding Rail Back; Copy Panel; Top Accent Bar; End Caps

Graphic Process

Surface applied vinyl.

Colors

Text & Arrows: Refer to Color Chart.
Background & Accent Bar: Refer to Color Chart

Typography

Helvetica Medium Condensed
75 mm (3") cap height required for all text.

Mounting

Braided stainless steel wire or rod.
Sign must not be attached directly to "T Grid" or lift out ceiling tile.

Installation

From the ceiling.

Recommendations

This sign is for use in corridors to direct patients and public through the building. Because of required letter height there is a limit to the length of messages and limited number of messages.

IN-15.01

↑ Canteen

IN-15.02

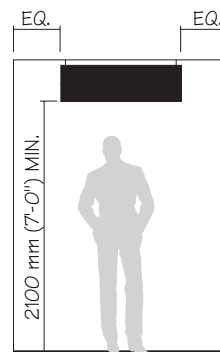
↑ Canteen
← Spinal Rehab

IN-15.03

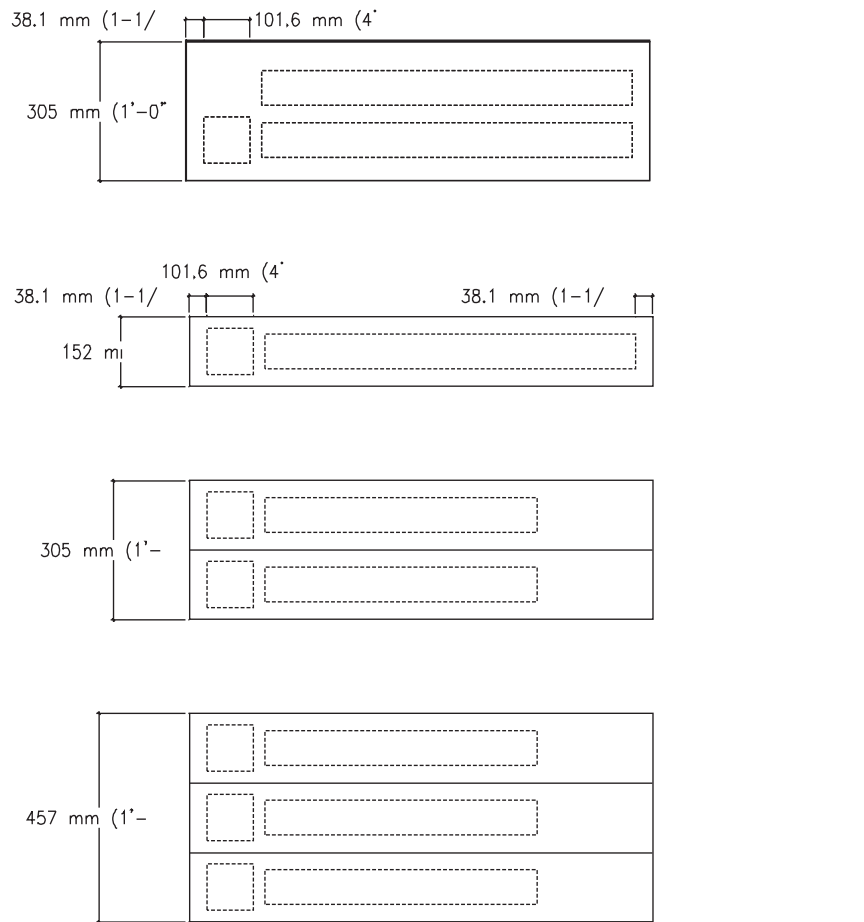
↑ Emergency
← Spinal Rehab
← Canteen

IN-15.04

Outpatient
← Registration



Ceiling Mounted Directional Sign



ARROW: R -> L
and/or arrow
positioning relative
to sign.

IN-15.05-8

Interior Signs Ê

Ceiling Mounted Directional Sign

Size

IN-15.05
152 mm x 2033 mm
(6" x 80")

IN-15.06
305 mm x 2033 mm
(12" x 80")

IN-15.07
457 mm x 2033 mm
(18" x 80")

IN-15.08
305 mm x 2033 mm
(12" x 80")

Description & Use

Use this sign for directional information that needs to be communicated overhead. Sign is double sided and both sides can be used for messages.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Sliding Rail Back; Copy Panel; Top Accent Bar; End Caps

Graphic Process

Surface applied vinyl.

Colors

Text & Arrows: Refer to Color Chart.
Background & Accent Bar: Refer to Color Chart

Typography

Helvetica Medium Condensed
75 mm (3") cap height required for all text.

Mounting

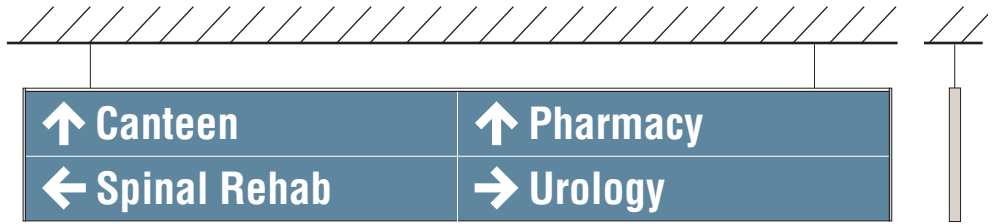
Braided stainless steel wire or rod.
Sign must not be attached directly to "T Grid" or lift out ceiling tile.

Installation

From the ceiling.

Recommendations

This sign is for use in corridors to direct patients and public through the building. Because of required letter height there is a limit to the length of messages and limited number of messages.



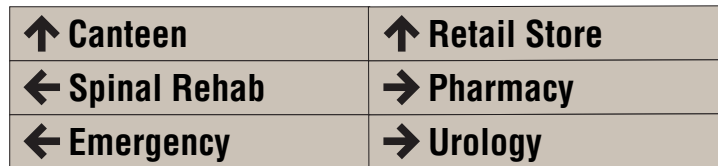
IN-15.05



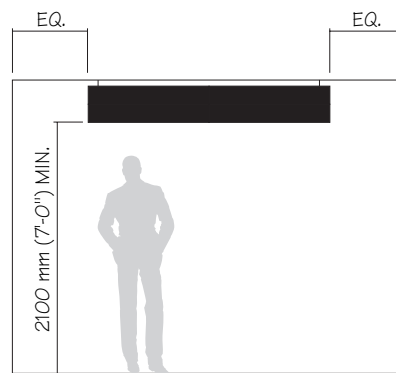
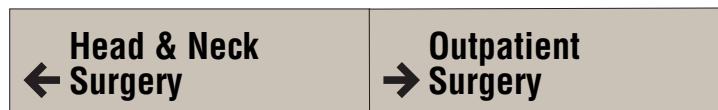
IN-15.06



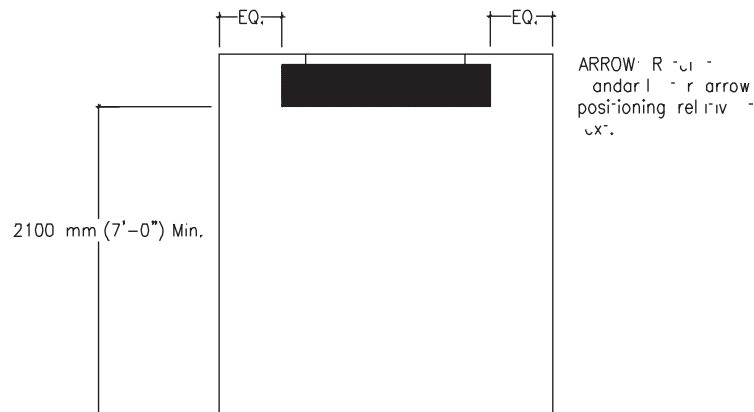
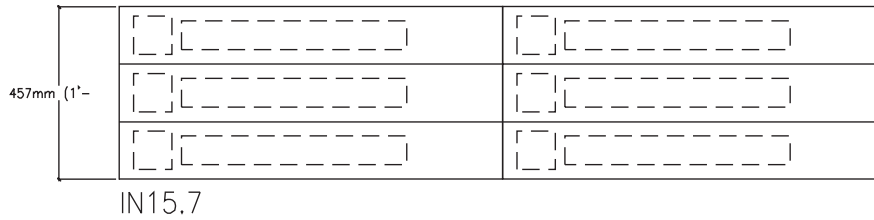
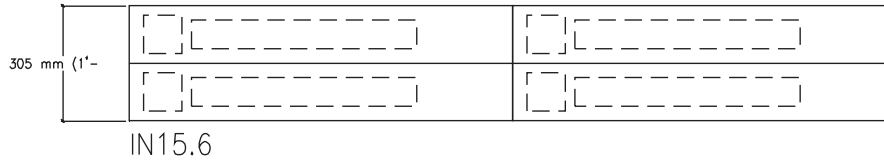
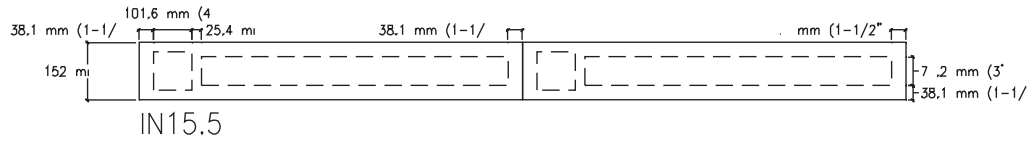
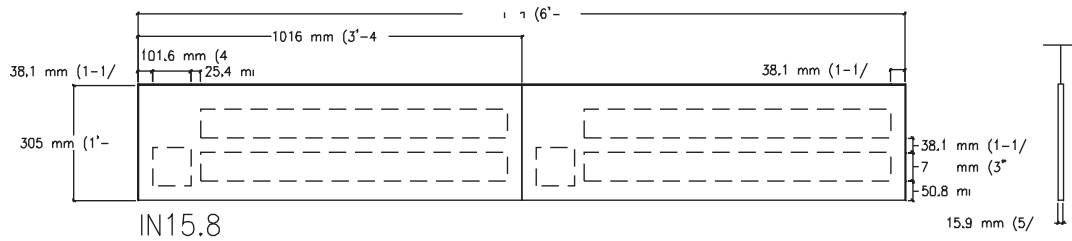
IN-15.07



IN-15.08



Ceiling Mounted Directional Sign



Soffit Mounted Directional Sign

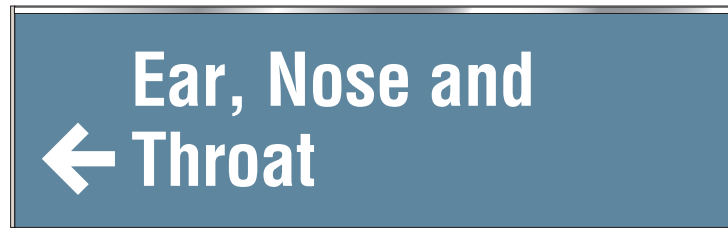
Size

IN-15.09
152 mm x 1016 mm
(6" x 40")

IN-15.10
305 mm x 1016 mm
(12" x 40")

IN-15.11
457 mm x 1016 mm
(18" x 40")

IN-15.12
305 mm x 1016 mm
(12" x 40")



Description & Use

Use this sign for directional information that needs to be communicated overhead.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Sliding Rail Back; Copy Panel; Top Accent Bar; End Caps

Graphic Process

Surface applied vinyl.

Colors

Text & Arrows: Refer to Color Chart.
Background & Accent Bar: Refer to Color Chart

Typography

Helvetica Medium Condensed
75 mm (3") cap height required for all text.

Mounting

Double sided foam tape, silastic adhesive or screw.

Installation

On soffits above doors, alcoves and counters.

Recommendations

This sign is for use in corridors to direct patients and public through the building. Because of required letter height there is a limit to the length of messages and limited number of messages.

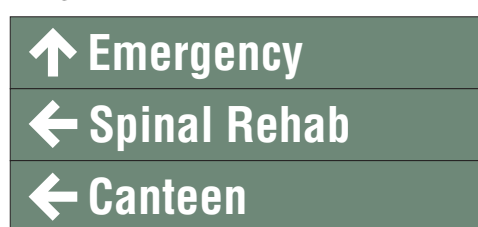
IN-15.09



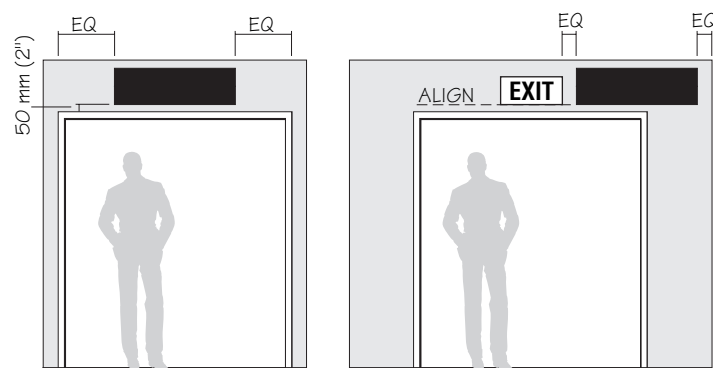
IN-15.10

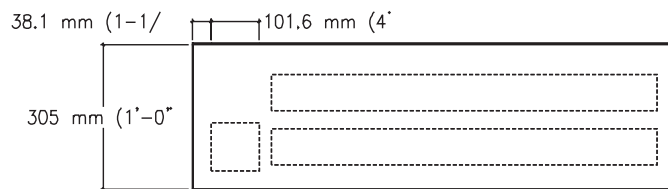


IN-15.11

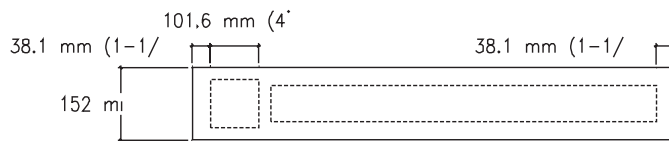


IN-15.12

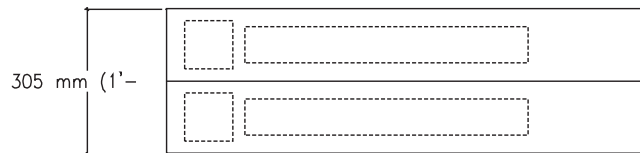




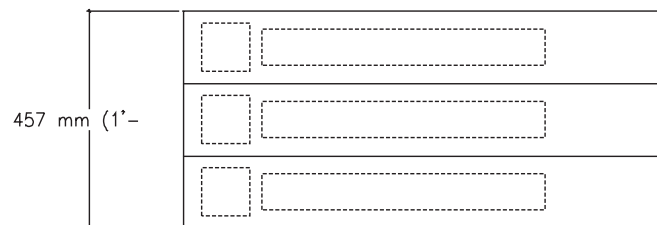
IN15.12



IN15.09



IN15.10



IN15.11

ARROW: Right
and/or left arrow
positioning relative to
text.

IN-15.13-16

Interior Signs Ê

Soffit Mounted Directional Sign

Size

IN-15.13
152 mm x 2033 mm
(6" x 80")

IN-15.14
305 mm x 2033 mm
(12" x 80")

IN-15.15
457 mm x 2033 mm
(18" x 80")

IN-15.16
305 mm x 2033 mm
(12" x 80")

Description & Use

Use this sign for directional information that needs to be communicated overhead.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Sliding Rail Back; Copy Panel; Top Accent Bar; End Caps

Graphic Process

Surface applied vinyl.

Colors

Text & Arrows: Refer to Color Chart.
Background & Accent Bar: Refer to Color Chart

Typography

Helvetica Medium Condensed
75 mm (3") cap height required for all text.

Mounting

Double sided foam tape, silastic adhesive or screw.

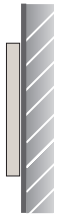
Installation

On soffits above doors, alcoves and counters.

Recommendations

This sign is for use in corridors to direct patients and public through the building. Because of required letter height there is a limit to the length of messages and limited number of messages.

↑ Canteen	↑ Pharmacy
← Spinal Rehab	→ Urology



IN-15.13

↑ Canteen	↑ Pharmacy
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IN-15.14

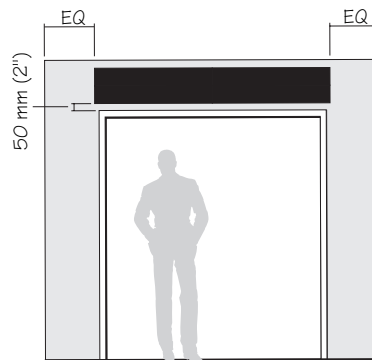
↑ Canteen	↑ Pharmacy
← Spinal Rehab	→ Urology

IN-15.15

↑ Canteen	↑ Retail Store
← Spinal Rehab	→ Pharmacy
← Emergency	→ Urology

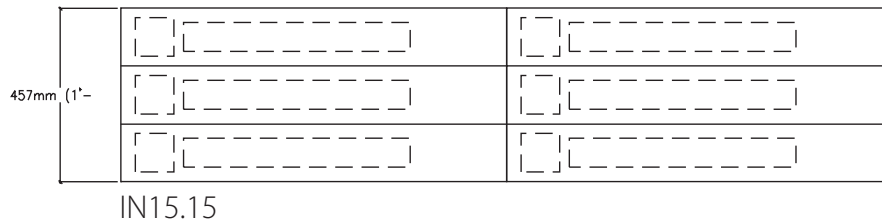
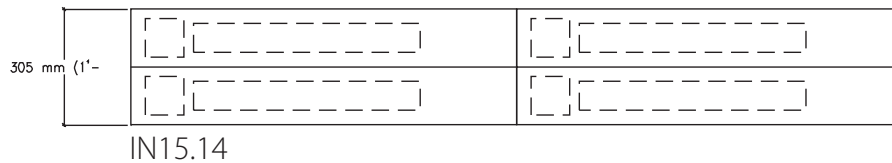
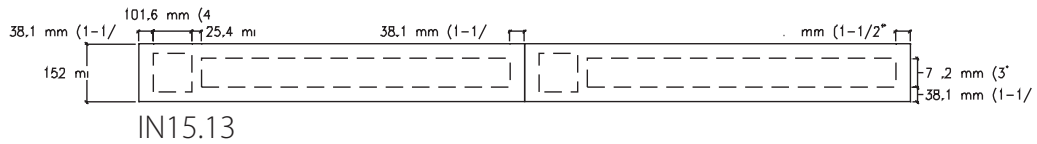
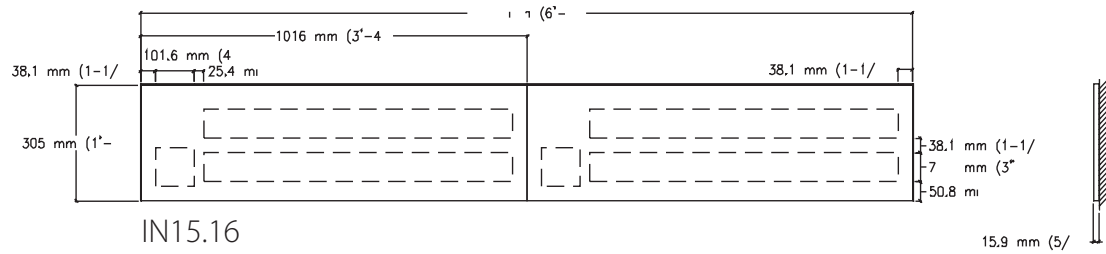
IN-15.16

← Head & Neck Surgery	→ Outpatient Surgery
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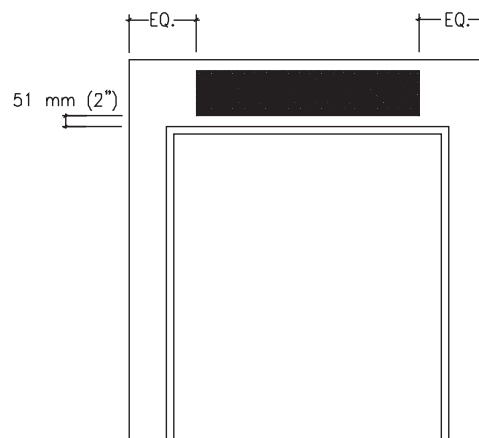


IN-15.13-16 Interior Signs Ê

Soffit Mounted Directional Sign



ARROW: Right
and/or Left arrow
positioning relative to
text.



IN-16.01-4

Interior Signs Ê

Ceiling Mounted Identification Sign

Size

IN-16.01
152 mm x 1016 mm
(6" x 40")

IN-16.02
305 mm x 1016 mm
(12" x 40")

IN-16.03
457 mm x 1016 mm
(18" x 40")

IN-16.04
305 mm x 1016 mm
(12" x 40")



Description & Use

Use this sign for identifying a department overhead. Sign is double sided and both sides can be used for messages.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Sliding Rail Back; Copy Panel; Top Accent Bar; End Caps

Graphic Process

Surface applied vinyl.

Colors

Text: Refer to Color Chart.
Background & Accent Bar: Refer to Color Chart

Typography

Helvetica Medium Condensed
75 mm (3") cap height required for all text.

Mounting

Braided stainless steel wire or rod.
Sign must not be attached directly to "T Grid" or lift out ceiling tile.

Installation

From the ceiling.

Recommendations

This sign is for use throughout a building. Because of required letter height there is a limit to the length of messages and limited number of messages.

IN-16.01

Emergency

IN-16.02

Canteen

Vending

IN-16.03

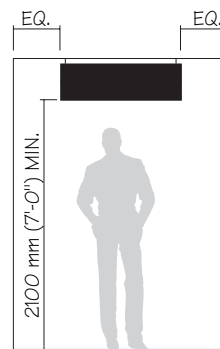
Canteen

Retail Store

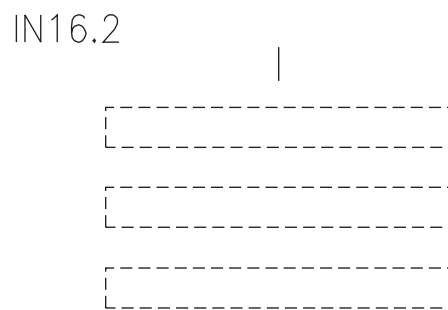
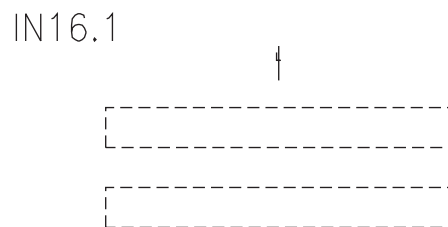
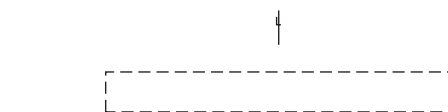
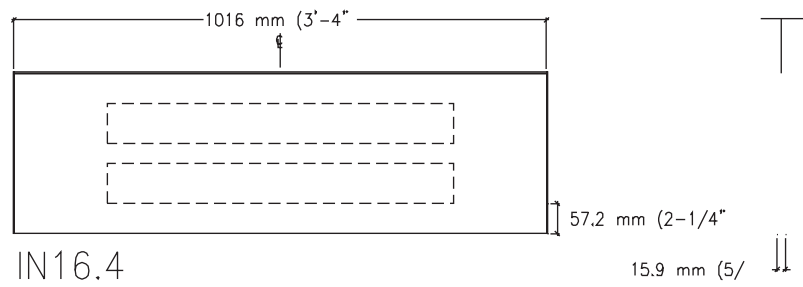
ATM & Vending

IN-16.04

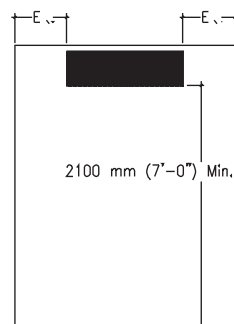
Outpatient Receptionist
& Registration



Ceiling Mounted Identification Sign



IN16.3



IN-16.05-8

Interior Signs Ê

Ceiling Mounted Identification Sign

Size

IN-16.05
152 mm x 2033 mm
(6" x 80")

IN16.06
30-5 mm x 2033 mm
(12" x 80")

IN-16.07
457 mm x 2033 mm
(18" x 80")

IN-16.08
305 mm x 2033 mm
(12" x 80")

Description & Use

Use this sign for identifying a department overhead. Sign is double sided and both sides can be used for messages.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Sliding Rail Back; Copy Panel; Top Accent Bar; End Caps

Graphic Process

Surface applied vinyl.

Colors

Text: Refer to Color Chart.
Background & Accent Bar: Refer to Color Chart

Typography

Helvetica Medium Condensed
75 mm (3") cap height required for all text.

Mounting

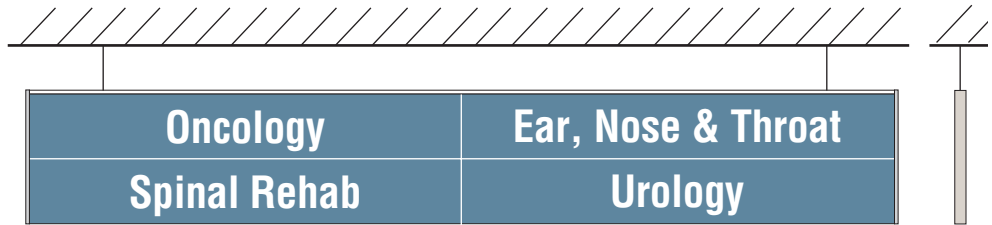
Braided stainless steel wire or rod.
Sign must not be attached directly to "T Grid" or lift out ceiling tile.

Installation

From the ceiling.

Recommendations

This sign is for use throughout a building. Because of required letter height there is a limit to the length of messages and limited number of messages.



IN-16.05

Oncology	Radiology
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IN-16.06

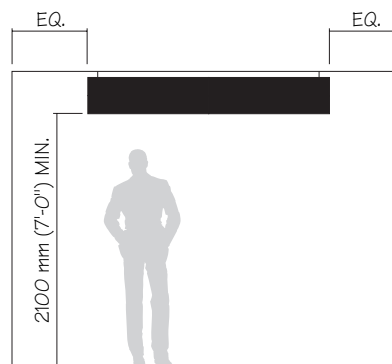
Oncology	Radiology
Spinal Rehab	Urology

IN-16.07

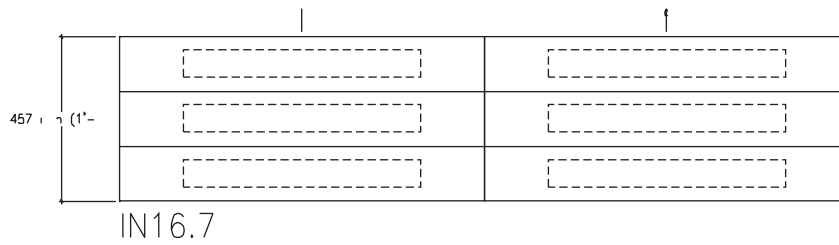
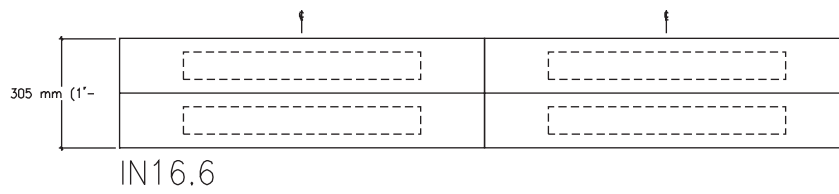
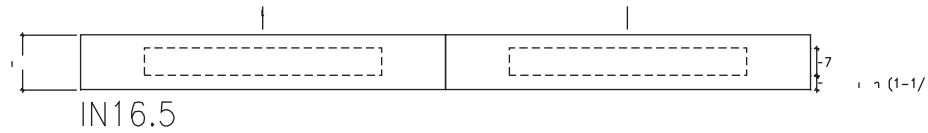
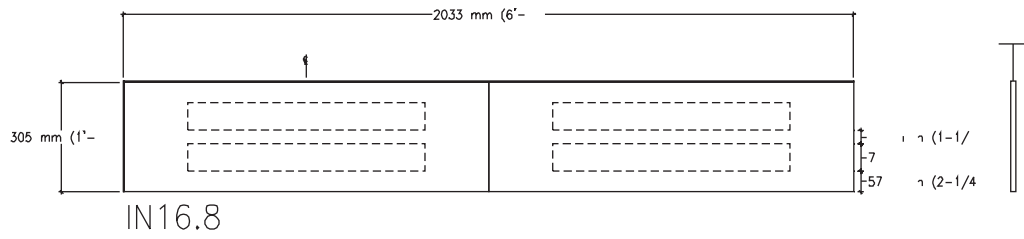
Oncology	Radiology
Spinal Rehab	PTSD
Canteen	Urology

IN-16.08

Head & Neck Surgery	Outpatient Opthamology
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Ceiling & Soffit Identification Sign



Soffit Mounted Identification Sign

Size

IN-16.09
152 mm x 1016 mm
(6" x 40")

IN-16.10
305 mm x 1016 mm
(12" x 40")

IN-16.11
457 mm x 1016 mm
(18" x 40")

IN-16.12
305 mm x 1016 mm
(12" x 40")



Description & Use

Use this sign for identifying a department overhead.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Sliding Rail Back; Copy Panel; Top Accent Bar; End Caps

Graphic Process

Surface applied vinyl.

Colors

Text: Refer to Color Chart.
Background & Accent Bar: Refer to Color Chart

Typography

Helvetica Medium Condensed
75 mm (3") cap height required for all text.

Mounting

Double sided foam tape, silastic adhesive or screw.

Installation

On soffits above doors, alcoves and counters.

Recommendations

This sign is for use throughout a building. Because of required letter height there is a limit to the length of messages and limited number of messages.

IN-16.09



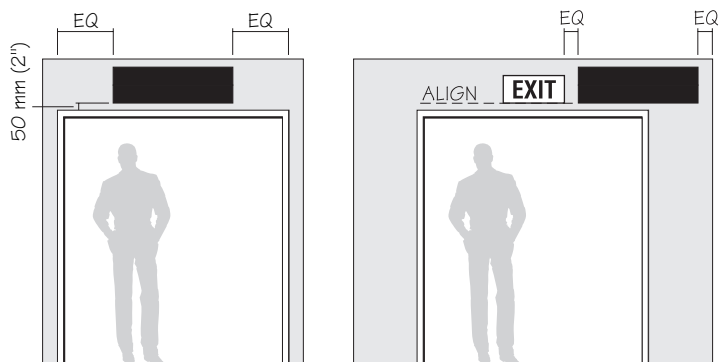
IN-16.10



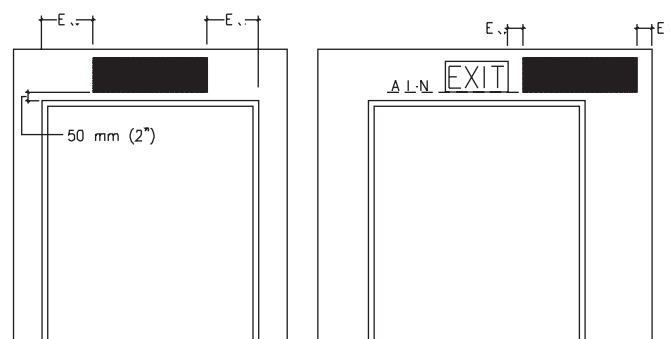
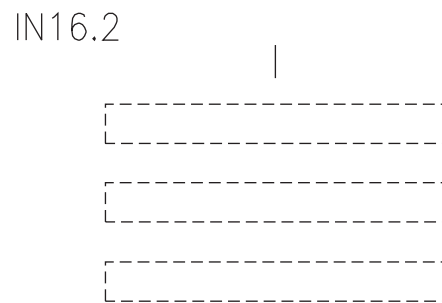
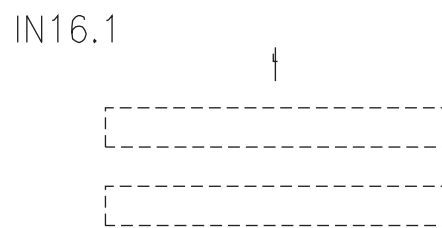
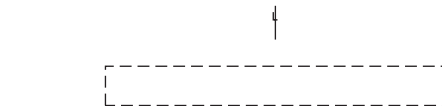
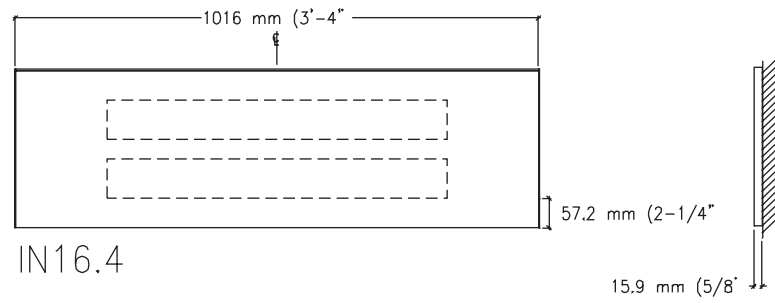
IN-16.11



IN-16.12



Soffit Mounted Identification Sign



IN-16.13-16

Interior Signs Ê

Ceiling Mounted Identification Sign

Size

IN-16.13
152 mm x 2033 mm
(6" x 80")

IN-16.14
30-5 mm x 2033 mm
(12" x 80")

IN-16.15
457 mm x 2033 mm
(18" x 80")

IN-16.16
305 mm x 2033 mm
(12" x 80")

Description & Use

Use this sign for identifying a department overhead.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Sliding Rail Back; Copy Panel; Top Accent Bar; End Caps

Graphic Process

Surface applied vinyl.

Colors

Text: Refer to Color Chart.
Background & Accent Bar: Refer to Color Chart

Typography

Helvetica Medium Condensed
75 mm (3") cap height required for all text.

Mounting

Double sided foam tape, silastic adhesive or screw.

Installation

On soffits above doors, alcoves and counters.

Recommendations

This sign is for use throughout a building. Because of required letter height there is a limit to the length of messages and limited number of messages.

Oncology	Ear, Nose & Throat
Spinal Rehab	Urology



IN-16.13

Oncology	Radiology
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IN-16.14

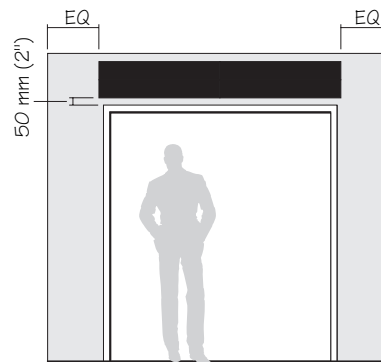
Oncology	Radiology
Spinal Rehab	Urology

IN-16.15

Oncology	Radiology
Spinal Rehab	PTSD
Canteen	Urology

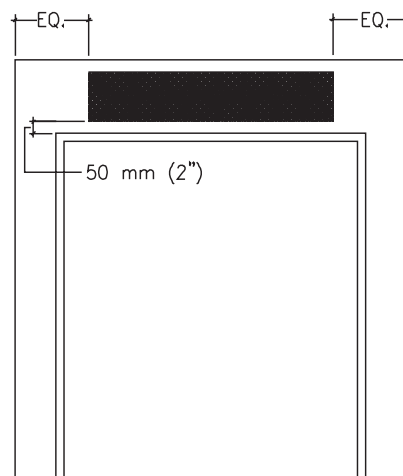
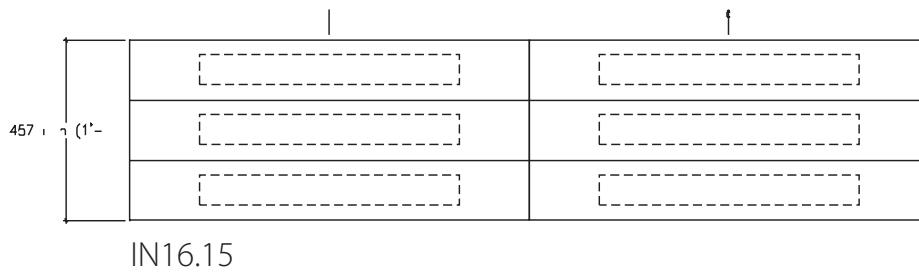
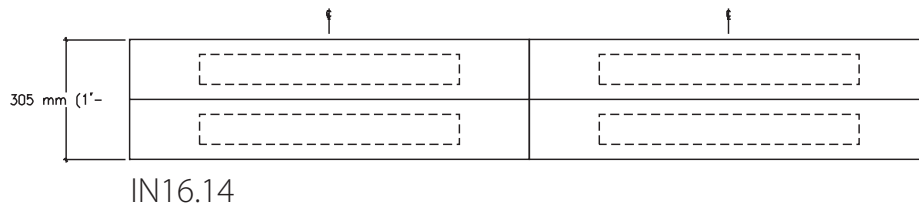
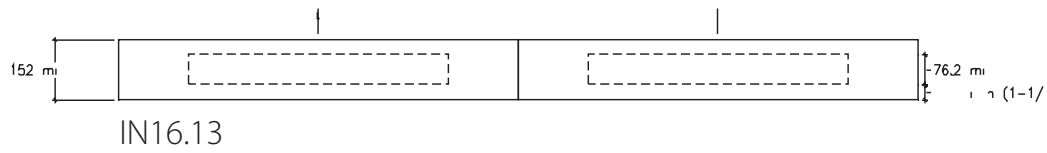
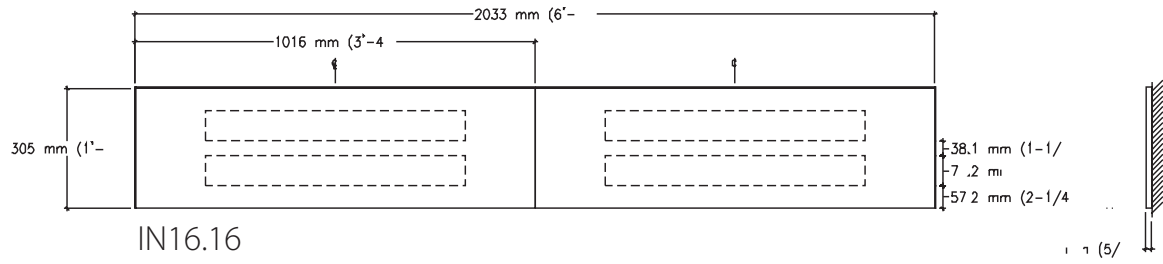
IN-16.16

Head & Neck Surgery	Outpatient Opthamology
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IN-16.13-16 Interior Signs Ê

Ceiling Mounted Identification Sign



Directory

Size

762 mm H x 610 mm W
(2'-6" H x 2'-0" W)

Description & Use

Small size main lobby directory. 48 directory strips.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)
Header Layout A is for a basic directory header. Header Layout B is for a directory header to contain the name of the facility. Copy Strip A is for use with the main listings. Copy Strip B is for a secondary listing under a main listing or when the name is too long to fit on Strip A.

Sign Components

Sliding Rail Back; Copy Panel; Top Accent Bar; End Caps

Graphic Process

Surface applied vinyl.

Colors

Text: Refer to Color Chart.
Background & Accent Bar: Refer to Color Chart

Typography

Helvetica Medium

Mounting

Screw.

Installation

On wall.

Recommendations

This directory is for use in the main lobby of small buildings which would typically have no more than 30 to 40 listings. All listings in a directory should be done in alphabetical order. List in the directory only services or departments which have contact with patients and public. Distribute any blank directory strips throughout the directory to provide spacing between groups of listings.

Directory			
Title		Title	
Subtitle	1A74	Subtitle	2A42
Subtitle	1A76	Sub-Subtitle	
Subtitle	1A77	Sub-Subtitle	
Subtitle	1A78	Sub-Subtitle	
Sub-Subtitle		Subtitle	2A44
Sub-Subtitle		Subtitle	2A45
		Subtitle	2A46
Title		Subtitle	2A48
Subtitle	1B48	Subtitle	2A52
Subtitle	1B49		
Subtitle	1B52	Title	
		Subtitle	2B32
Title		Subtitle	2B34
Subtitle	1C32		
Subtitle	1C33	Title	
Subtitle	1C36	Subtitle	3A54
Subtitle	1C38	Sub-Subtitle	
		Sub-Subtitle	
		Sub-Subtitle	
		Subtitle	3A55
		Subtitle	3A56

Header (Message Layout A)



Header (Message Layout B)



Copy Strip A

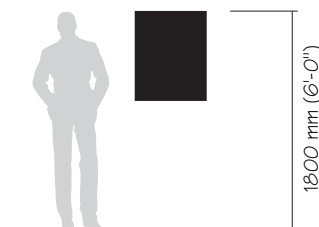
Title	1A74
-------	------

Copy Strip B

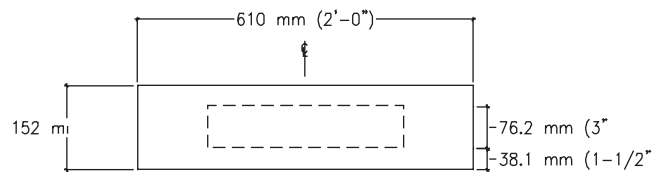
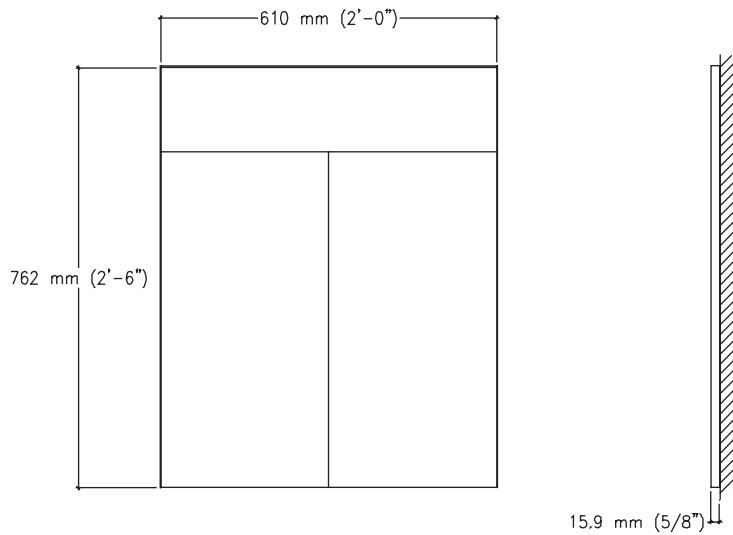
Subtitle	1B48
----------	------

Copy Strip C

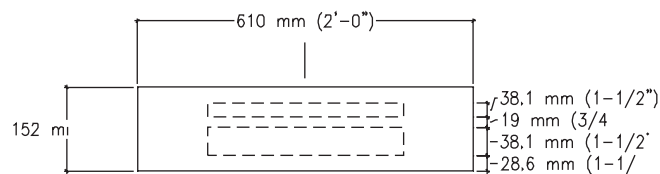
Sub-Subtitle	1C49
--------------	------



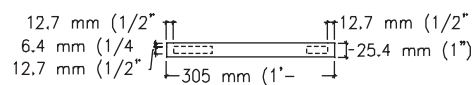
Directory



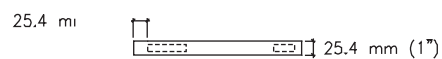
Header A



Header B



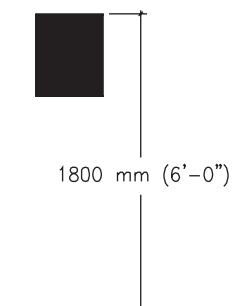
Copy Strip A



Copy Strip B



Copy Strip C



Large Directory

Size

915 mm H x 915 mm W
(3'-0" H x 3'-0" W)

Description & Use

Main lobby directory. 90 directory strips.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)
Header Layout A is for a basic directory header. Header Layout B is for a directory header to contain the name of the facility. Copy Strip A is for use with the main listings. Copy Strip B is for a secondary listing under a main listing or when the name is too long to fit on Strip A.

Sign Components

Sliding Rail Back; Copy Panel; Top Accent Bar; End Caps

Graphic Process

Surface applied vinyl.

Colors

Text: Refer to Color Chart.
Background & Accent Bar: Refer to Color Chart

Typography

Helvetica Medium

Mounting

Screw.

Installation

On wall.

Recommendations

This directory is for use in the main lobby of small buildings which would typically have no more than 60 to 80 listings. All listings in a directory should be done in alphabetical order. List in the directory only services or departments which have contact with patients and public. Distribute any blank directory strips throughout the directory to provide spacing between groups of listings

Directory					
Title		Title		Title	
Subtitle	1A74	Subtitle	2B37	Subtitle	2B37
Subtitle	1A75	Sub-Subtitle		Sub-Subtitle	
Subtitle	1A77	Sub-Subtitle		Sub-Subtitle	
Subtitle	1A78	Sub-Subtitle		Sub-Subtitle	
Sub-Subtitle		Subtitle	2B40	Subtitle	2B40
Sub-Subtitle		Subtitle	2B41	Subtitle	2B41
		Subtitle	2B42		
Title		Subtitle	2B44	Title	
Subtitle	1B48	Subtitle	2B45	Subtitle	2C50
Subtitle	1B49			Subtitle	2C55
Subtitle	1B51	Title			
		Subtitle	2C50	Title	
Title		Subtitle	2C55	Subtitle	2C60
Subtitle	1C34			Sub-Subtitle	
Subtitle	1C37	Title		Sub-Subtitle	
Subtitle	1C38	Subtitle	2C60	Sub-Subtitle	
Subtitle	1C42	Sub-Subtitle		Subtitle	2C61
		Sub-Subtitle		Subtitle	2C62
		Sub-Subtitle			
		Subtitle	2C61		
		Subtitle	2C62		

Header (Message Layout A)



Header (Message Layout B)



Copy Strip A

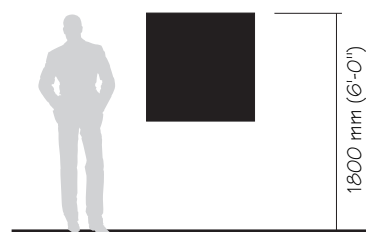
Title	1A74
-------	------

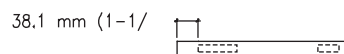
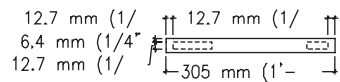
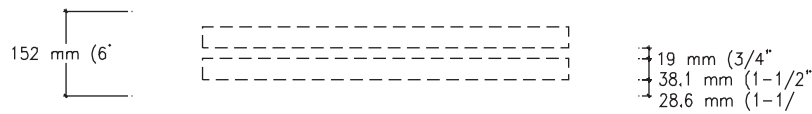
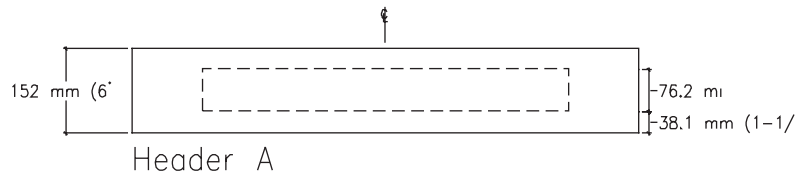
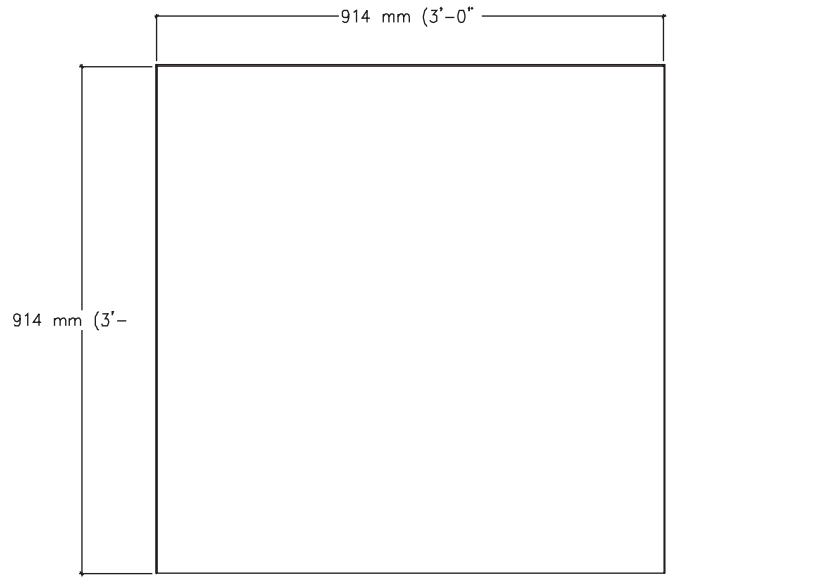
Copy Strip B

Subtitle	1B48
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Copy Strip C

Sub-Subtitle	1C49
--------------	------





Directory with Map

Size

762 mm H x 1220 mm W
(2'-6" H x 4'-0" W)

Description & Use

Small size main lobby directory with a map of the building. 48 directory strips.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)
Header Layout A is for a basic directory header. Header Layout B is for a directory header to contain the name of the facility. Copy Strip A is for use with the main listings. Copy Strip B is for a secondary listing under a main listing or when the name is too long to fit on Strip A.

Sign Components

Sliding Rail Back; Copy Panel; Top Accent Bar; End Caps

Graphic Process

Surface applied vinyl.

Colors

Text: Refer to Color Chart.
Background & Accent Bar: Refer to Color Chart

Typography

Helvetica Medium

Mounting

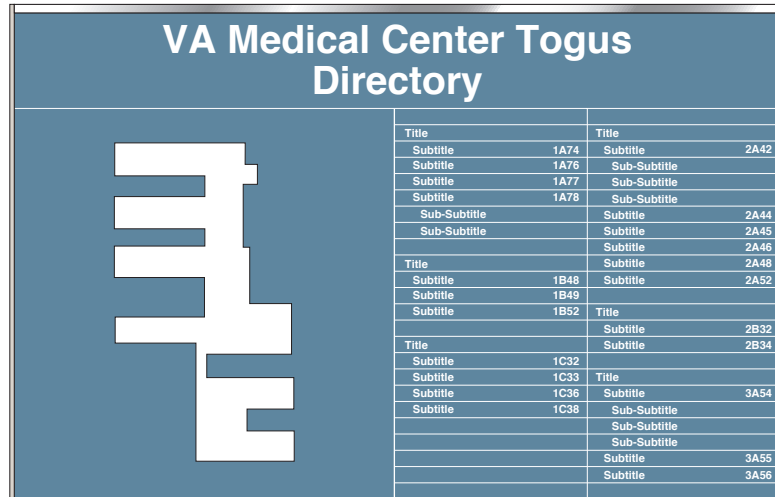
Screw.

Installation

On wall.

Recommendations

This directory is for use in the main lobby of small buildings which would typically have no more than 30 to 40 listings. All listings in a directory should be done in alphabetical order. List in the directory only services or departments which have contact with patients and public. Distribute any blank directory strips throughout the directory to provide spacing between groups of listings.
Maps should be simple and show the corridor system, major departments and locations of elevators. If a building has multiple floors, then all floors should be shown. Orientate floor plans to represent the building in the same direction as the map is being viewed.



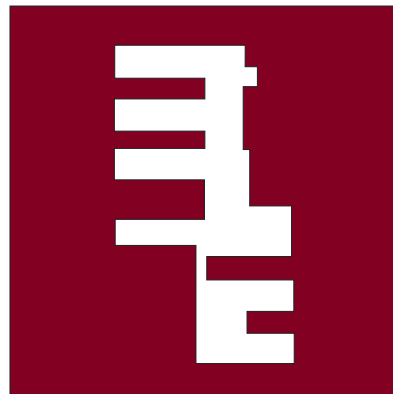
Header (Message Layout A)



Header (Message Layout B)



Map



Copy Strip A

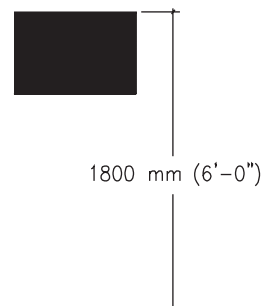
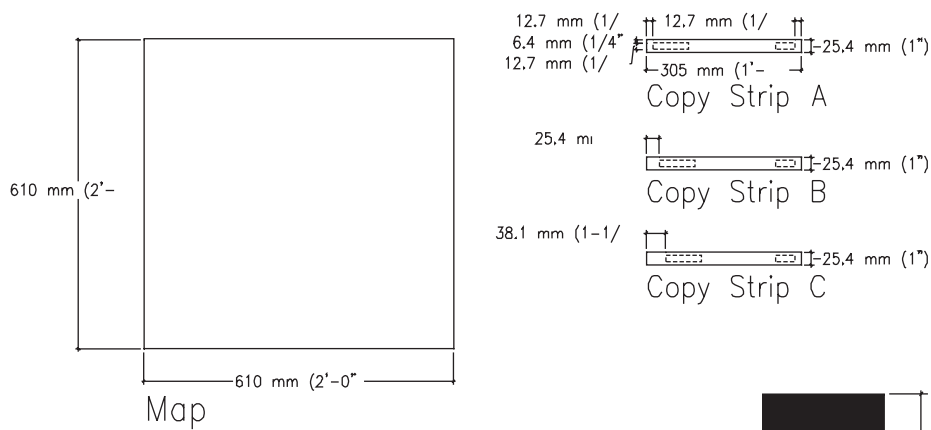
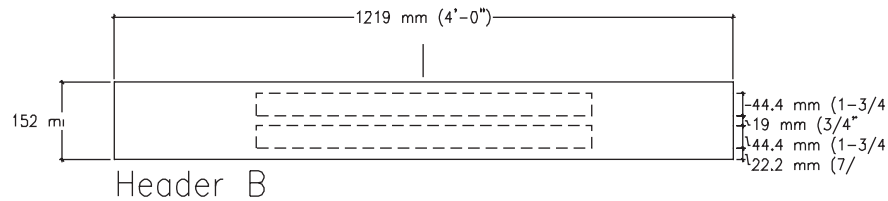
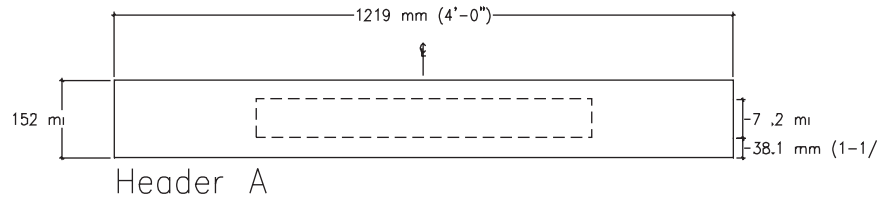
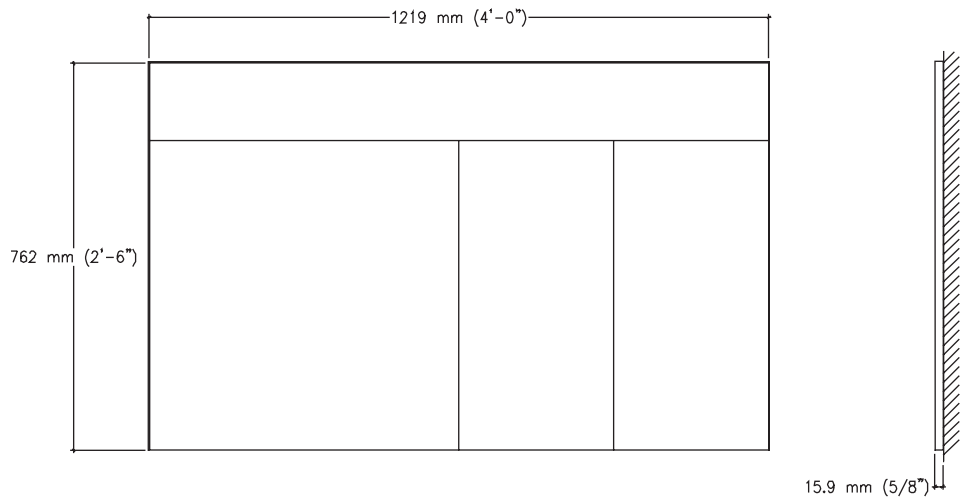


Copy Strip B



Copy Strip C





Size

915 mm H x 1525 mm W
(3'-0" H x 5'-0" W)

Description & Use

Main lobby directory with a map of the building. 90 directory strips.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)
Header Layout A is for a basic directory header. Header Layout B is for a directory header to contain the name of the facility. Copy Strip A is for use with the main listings. Copy Strip B is for a secondary listing under a main listing or when the name is too long to fit on Strip A.

Sign Components

Sliding Rail Back; Copy Panel; Top Accent Bar; End Caps

Graphic Process

Surface applied vinyl.

Colors

Text: Refer to Color Chart.
Background & Accent Bar: Refer to Color Chart

Typography

Helvetica Medium

Mounting

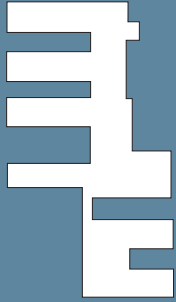
Screw.

Installation

On wall.

Recommendations

This directory is for use in the main lobby of small buildings which would typically have no more than 60 to 80 listings. All listings in a directory should be done in alphabetical order. List in the directory only services or departments which have contact with patients and public. Distribute any blank directory strips throughout the directory to provide spacing between groups of listings.
Maps should be simple and show the corridor system, major departments and locations of elevators. If a building has multiple floors, then all floors should be shown. Orientate floor plans to represent the building in the same direction as the map is being viewed.

Directory			
VA Medical Center Regional Milwaukee			
	Title	Title	Title
	Subtitle 1A74	Subtitle 2A42	Subtitle 1A74
	Subtitle 1A76	Sub-Subtitle	Subtitle 1A76
	Subtitle 1A77	Sub-Subtitle	Subtitle 1A77
	Subtitle 1A78	Sub-Subtitle	Subtitle 1A78
	Sub-Subtitle	Subtitle 2A44	
	Sub-Subtitle	Subtitle 2A45	Title
	Title	Subtitle 2A46	Subtitle 1B48
	Subtitle 1B49	Subtitle 2A48	Subtitle 1B49
	Subtitle 1B52	Subtitle 2A52	Subtitle 1B52
	Title	Title	Title
	Subtitle 2B32	Subtitle 2B34	Subtitle 1C32
	Subtitle 1C32	Title	Subtitle 1C33
	Subtitle 1C33	Subtitle 3A54	Subtitle 1C36
	Subtitle 1C36	Sub-Subtitle	Subtitle 1C38
	Subtitle 1C38	Sub-Subtitle	
		Sub-Subtitle	
		Subtitle 3A55	
		Subtitle 3A56	

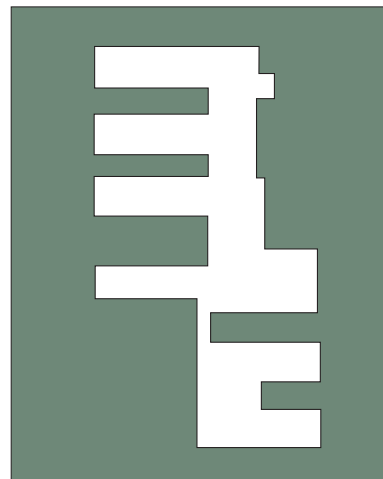
Header (Message Layout A)

Directory

Header (Message Layout B)

Directory
VA Medical Center Regional Milwaukee

Map



Copy Strip A

Title 1A74

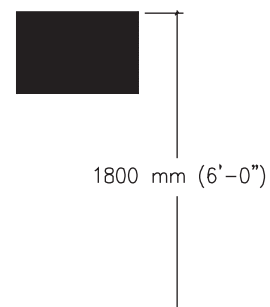
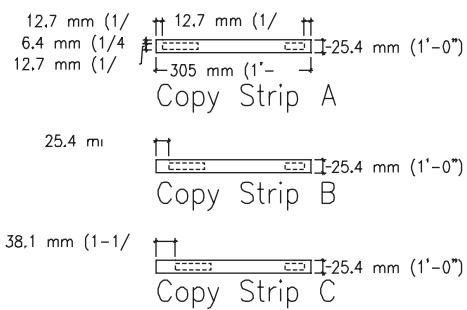
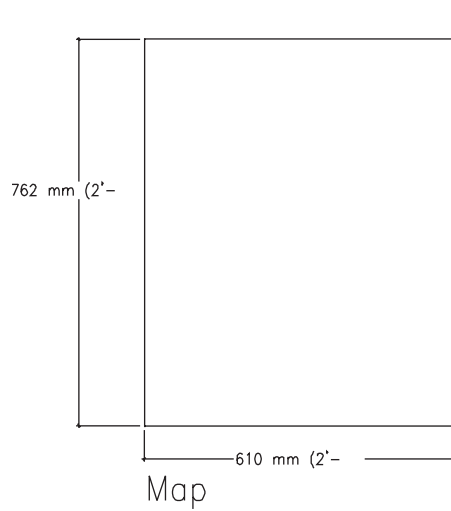
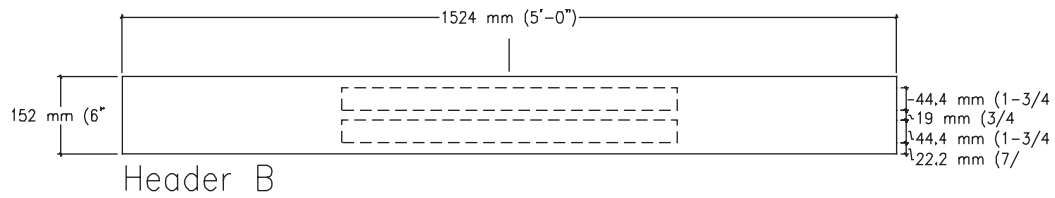
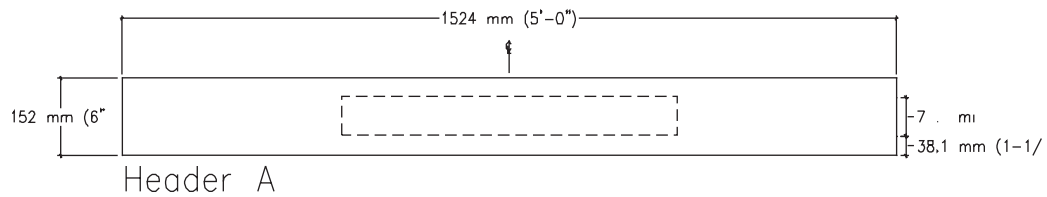
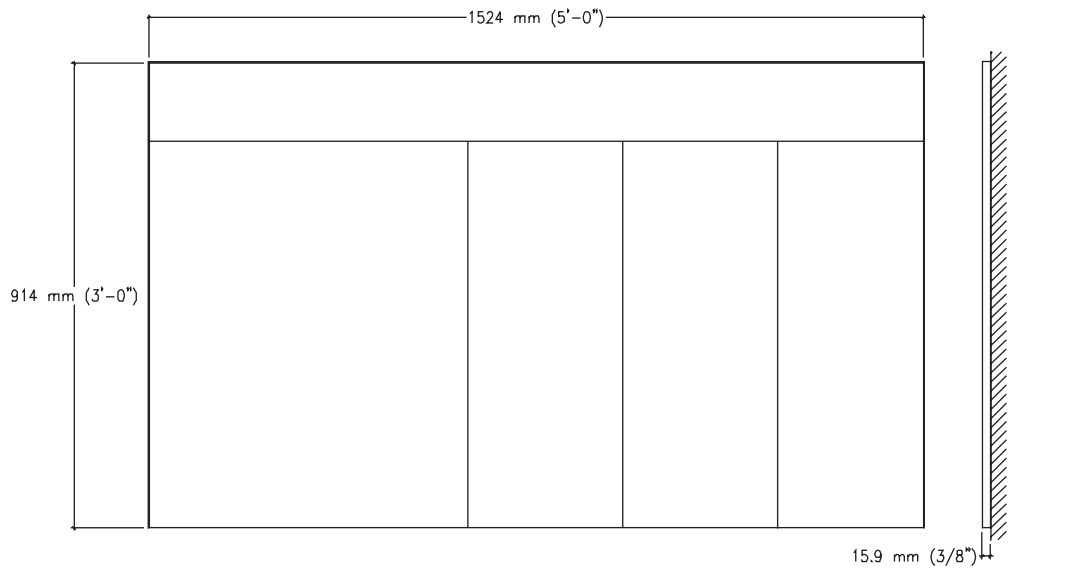
Copy Strip B

Subtitle 1B48

Copy Strip C

Sub-Subtitle 1C49





Floor Directory

Size

762 mm H x 305 mm W
(2'-6" H x 12" W)

Description & Use

Small size elevator lobby directory.
24 directory strips.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)
Header Layout A is for a single digit floor. Header Layout B is for a double digit floor. Copy Strip A is for use with the main listings. Copy Strip B is for a secondary listing under a main listing or when the name is too long to fit on Strip A.

Sign Components

Sliding Rail Back; Copy Panel; Top Accent Bar; End Caps

Graphic Process

Surface applied vinyl.

Colors

Text: Refer to Color Chart.
Background & Accent Bar: Refer to Color Chart

Typography

Helvetica Medium

Mounting

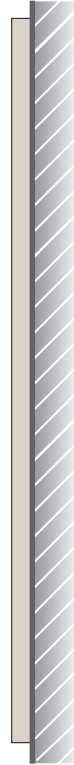
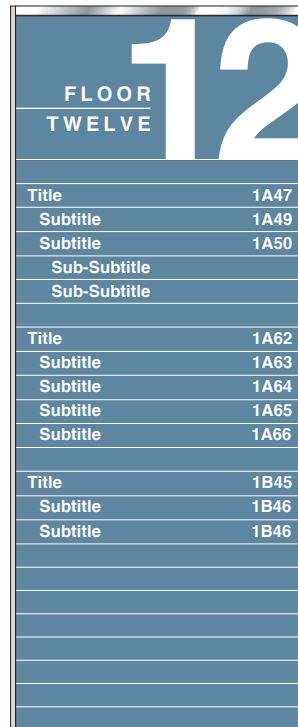
Screw.

Installation

On wall adjacent to elevator.

Recommendations

This directory is for use in the elevator lobbies of small buildings which would typically have no more than 20 listings. All listings in a directory should be done in alphabetical order. List in the directory only services or departments which have contact with patients and public. Distribute any blank directory strips throughout the directory to provide spacing between groups of listings.



Header (Layout A)



Header (Layout B)



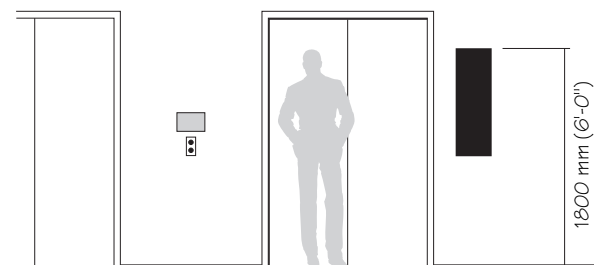
Directory Strip A



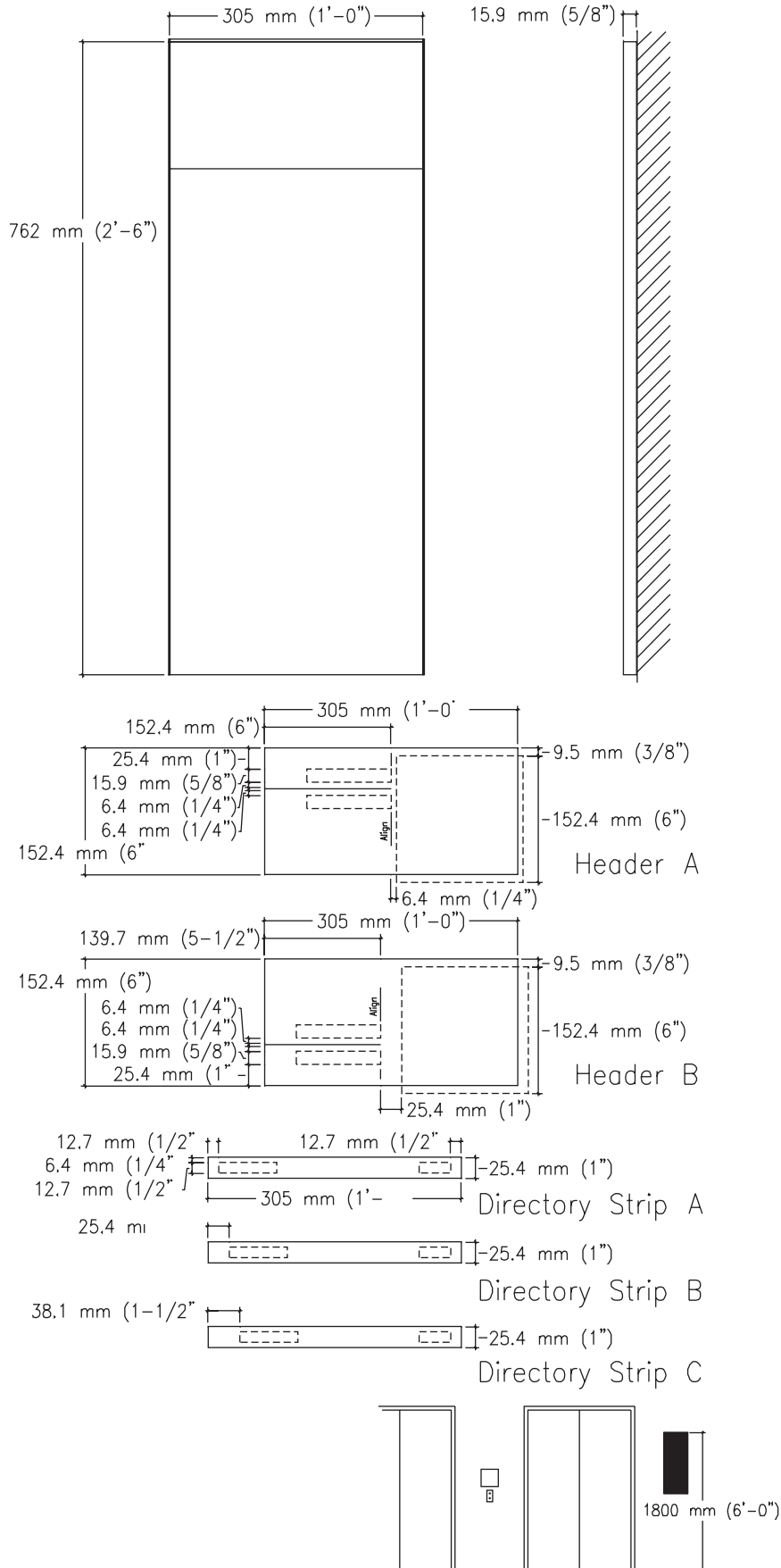
Directory Strip C



Directory Strip B



Floor Directory



Interior Signs Ê

Size

762 mm H x 610 mm W
(2'-6" H x 2'-0" W)

Description & Use

Elevator lobby directory. 48
directory strips.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)
Header Layout A is for a single digit floor. Header Layout B is for a double digit floor. Copy Strip A is for use with the main listings. Copy Strip B is for a secondary listing under a main listing or when the name is too long to fit on Strip A.

Sign Components

Sliding Rail Back; Copy Panel; Top
Accent Bar; End Caps

Graphic Process

Surface applied vinyl.

Colors

Text: Refer to Color Chart.
Background & Accent Bar: Refer to Color Chart

Typography

Helvetica Medium

Mounting

Screw.

Installation

On wall adjacent to elevator.

Recommendations

This directory is for use in the elevator lobbies of small buildings which would typically have no more than 40 listings. All listings in a directory should be done in alphabetical order. List in the directory only services or departments which have contact with patients and public. Distribute any blank directory strips throughout the directory to provide spacing between groups of listings.

		FLOOR TWELVE		12
Title	1A47	Title	1A47	
Subtitle	1A49	Subtitle	1A49	
Subtitle	1A50	Subtitle	1A50	
Sub-Subtitle		Sub-Subtitle		
		Sub-Subtitle		
Title	1A62			
Subtitle	1A63	Title	2A62	
Subtitle	1A64	Subtitle	2A63	
Subtitle	1A65	Subtitle	2A64	
Subtitle	1A66	Subtitle	2A65	
Subtitle	1A63	Subtitle	2A66	
Subtitle	1A64			
Subtitle	1A65	Title	2B45	
		Subtitle	2B46	
Title	1A62	Subtitle	2B46	
Subtitle	1A63			
Subtitle	1A64			
Subtitle	1A65			
Subtitle	1A66			

Header (Layout A)

FLOOR FOUR

Header (Layout B)

FLOOR
TWELVE

Directory Strip A

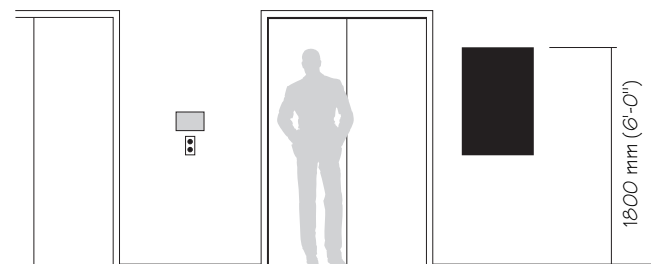
Title	1A74
-------	------

Directory Strip C

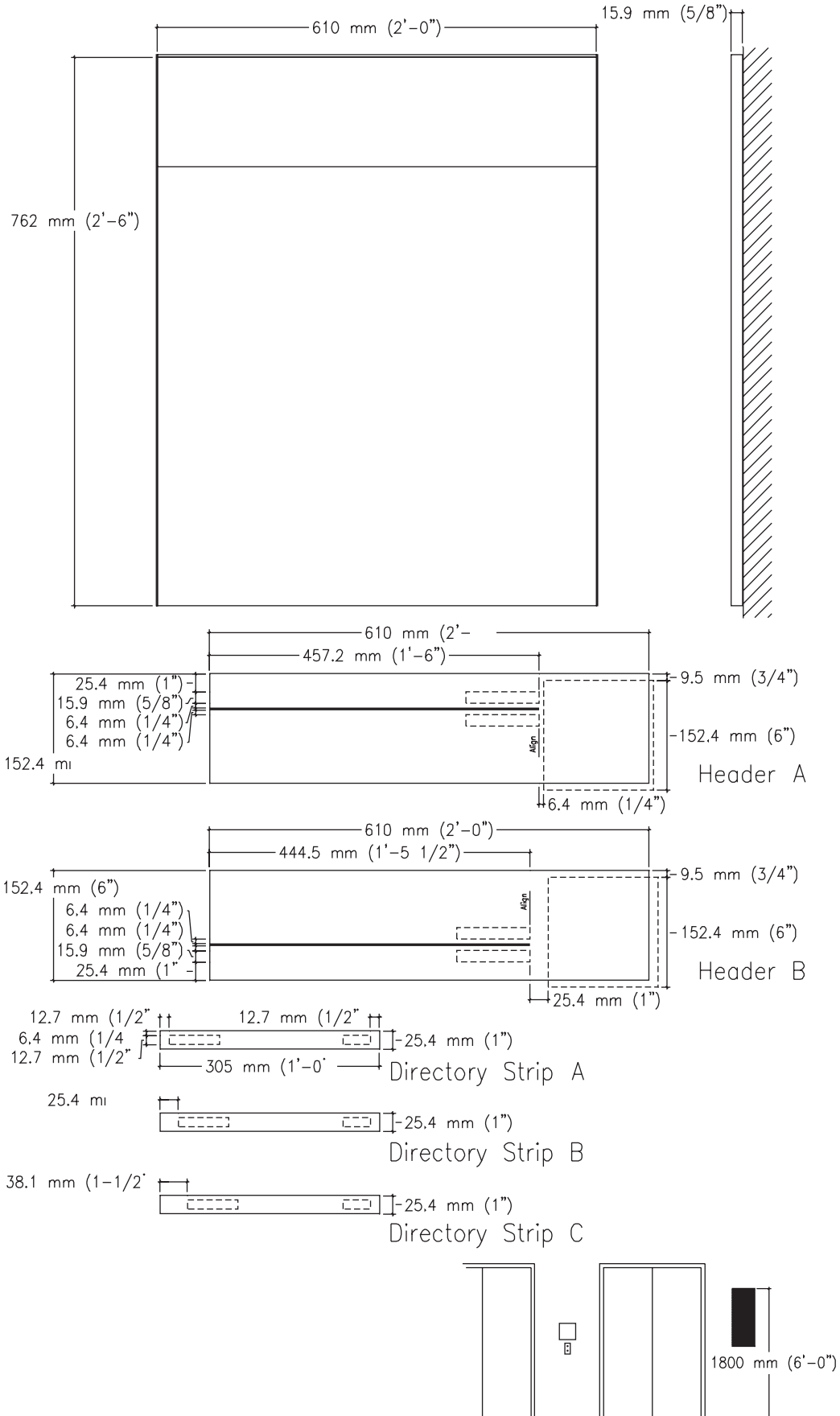
Sub-Subtitle 1C49

Directory Strip B

Subtitle 1B48



Large Floor Directory



Sign

38 mm H
(1 1/2" H)
51 mm H
(2" H)
(Other sizes as needed)

Description & Use

This sign is for use at the entry doors to rooms or departments that are used by patients and public

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Graphic Process

Surface applied vinyl.

Colors

Text: White - T1
Do not use black or colors.

Typography

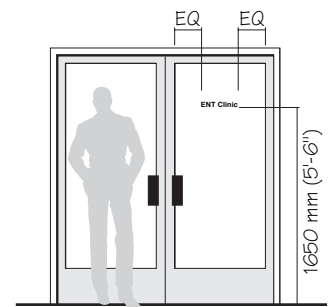
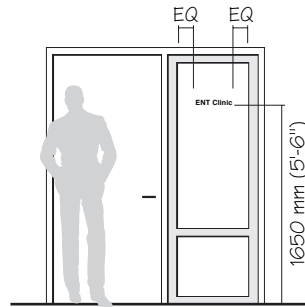
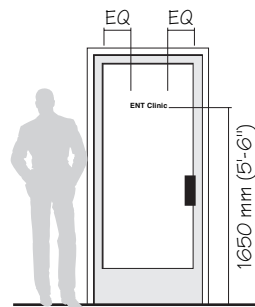
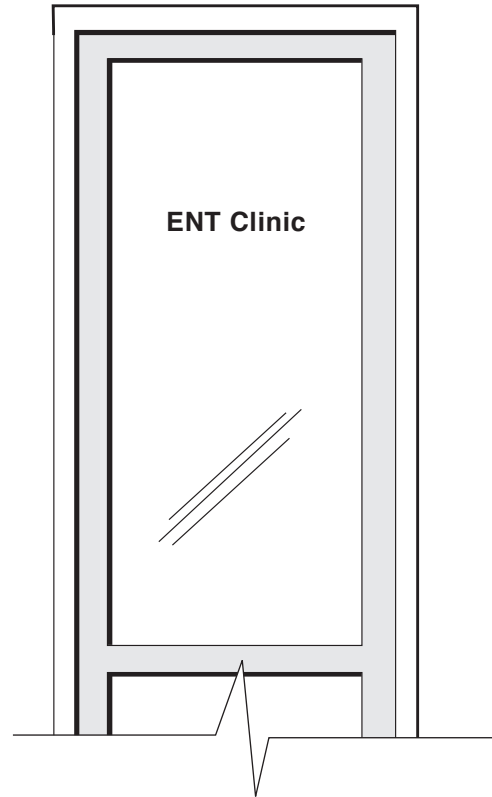
Helvetica Medium

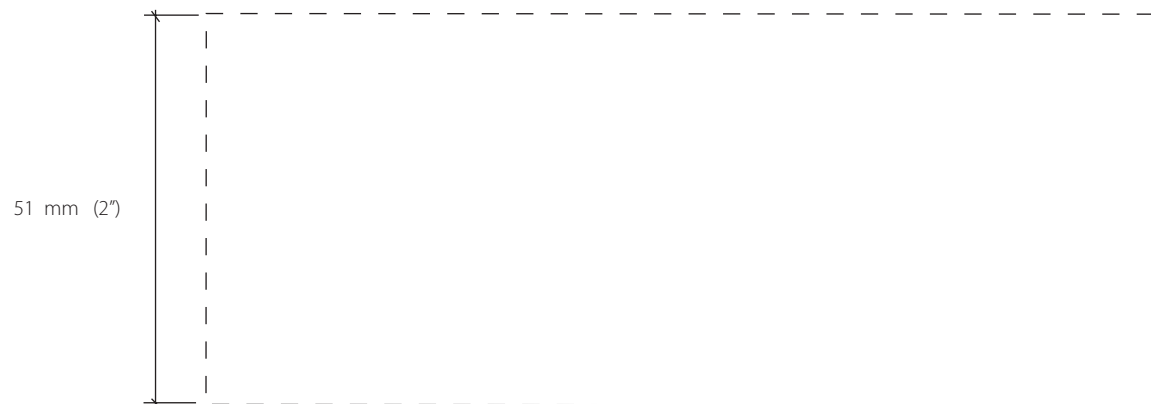
Mounting

Glass side light and glass doors.

Installation

Apply to front reading surface of glass or second surface of glass with reverse (backward) cut letters.





Size

IN-19.01

76 mm H x 10 mm D
(3" H x 3/8" D)

IN-19.02

102 mm H x 10 mm D
(4" H x 3/8" D)

IN-19.03

152 mm H x 10 mm D
(6" H x 3/8" D)**Description & Use**Identification of information
counters, major departments or
services.**Message Configuration**(Refer to layout drawing for
lettering sizes and dimensions)**Sign Components**

Painted acrylic.

Graphic Process

Cut out dimensional letters.

Colors

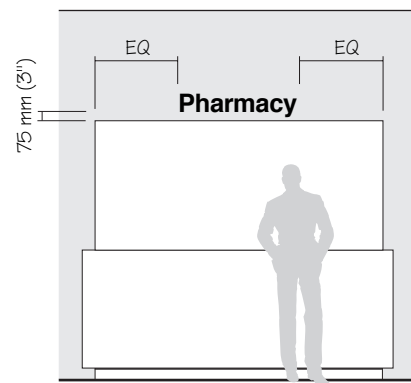
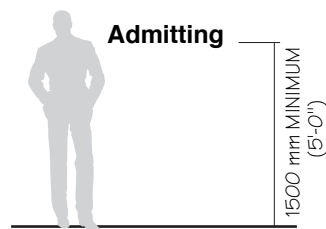
Text: Refer to Color Chart.

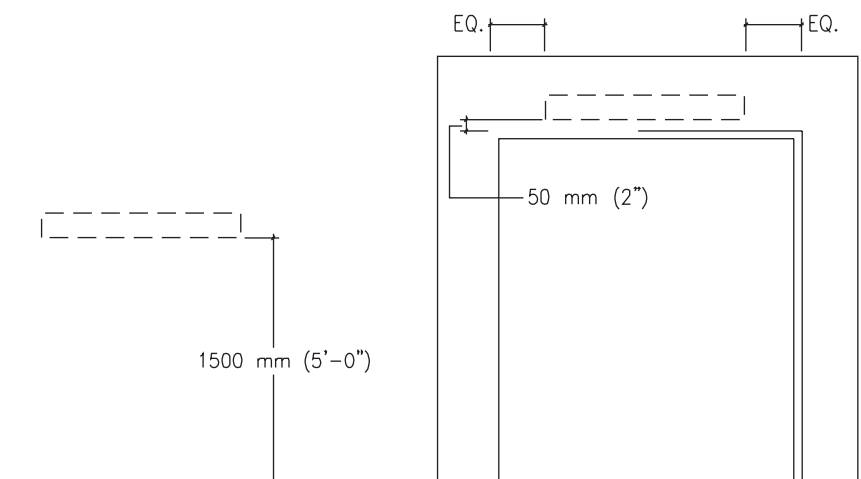
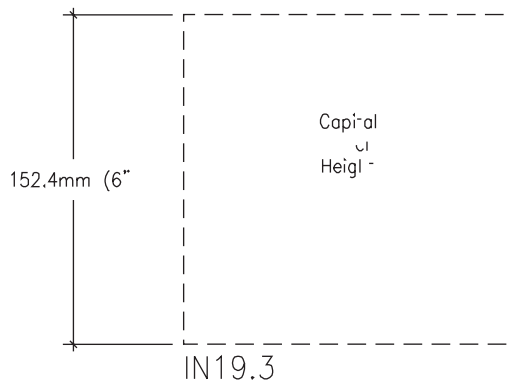
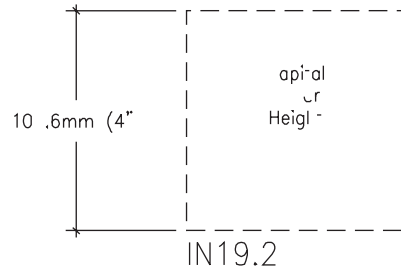
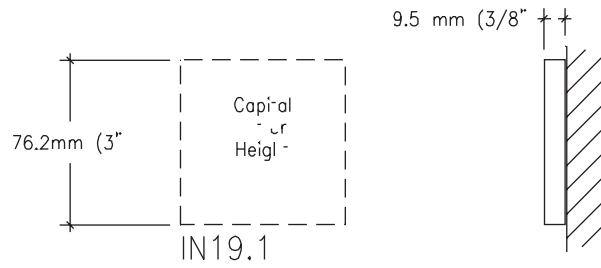
Color should have a high contrast
with surrounding wall color and
surface.**Typography**

Helvetica Medium

MountingSilastic adhesive or studs and
silastic adhesive.**Installation**

On walls or soffits.

RecommendationsDimensional letters provide high
impact, high visibility and formal
identification. Do not use for
departments or services that have
frequent relocation's or name
changes. Suggested typical uses
would be for Information, Check In,
Canteen, Pharmacy, etc.



Instructional Sign

Size

152 mm x 152 mm
(6" H x 6" W)

Description & Use

Use this sign above handicap accessible automatic door opening buttons.

Message Configuration

(Refer to layout drawing for lettering sizes and dimensions)

Sign Components

Painted acrylic.

Graphic Process

Silk-screened or surface applied vinyl.

Colors

Text: Refer to Color Chart.
Background: Refer to Color Chart

Typography

Helvetica Medium

Mounting

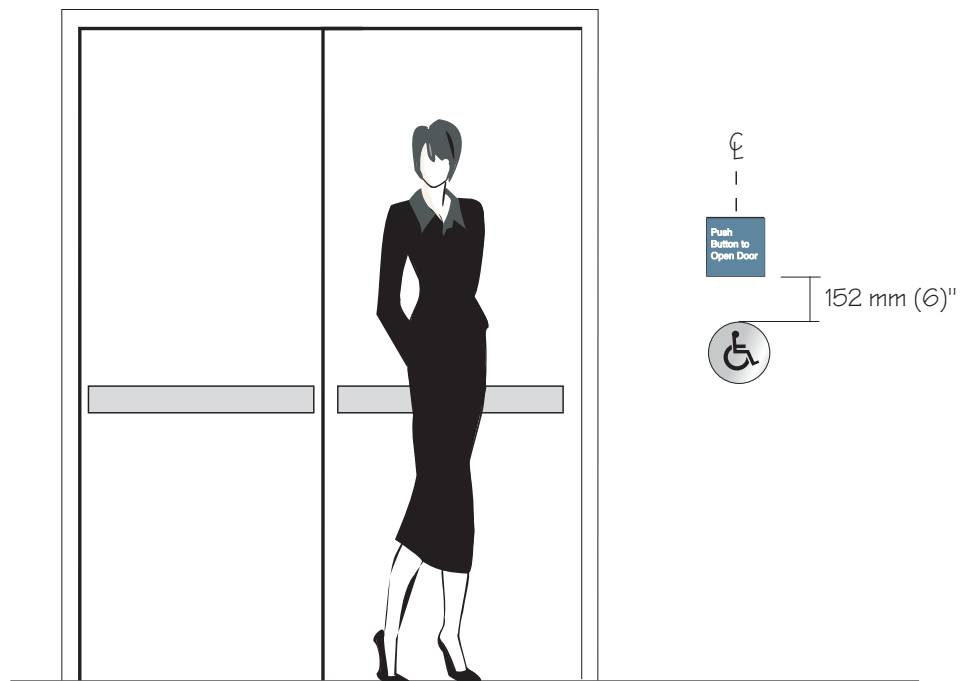
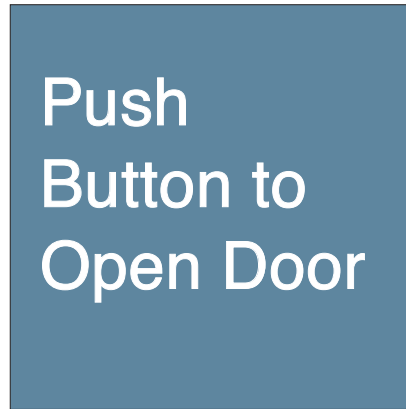
Double sided foam tape or silastic adhesive.

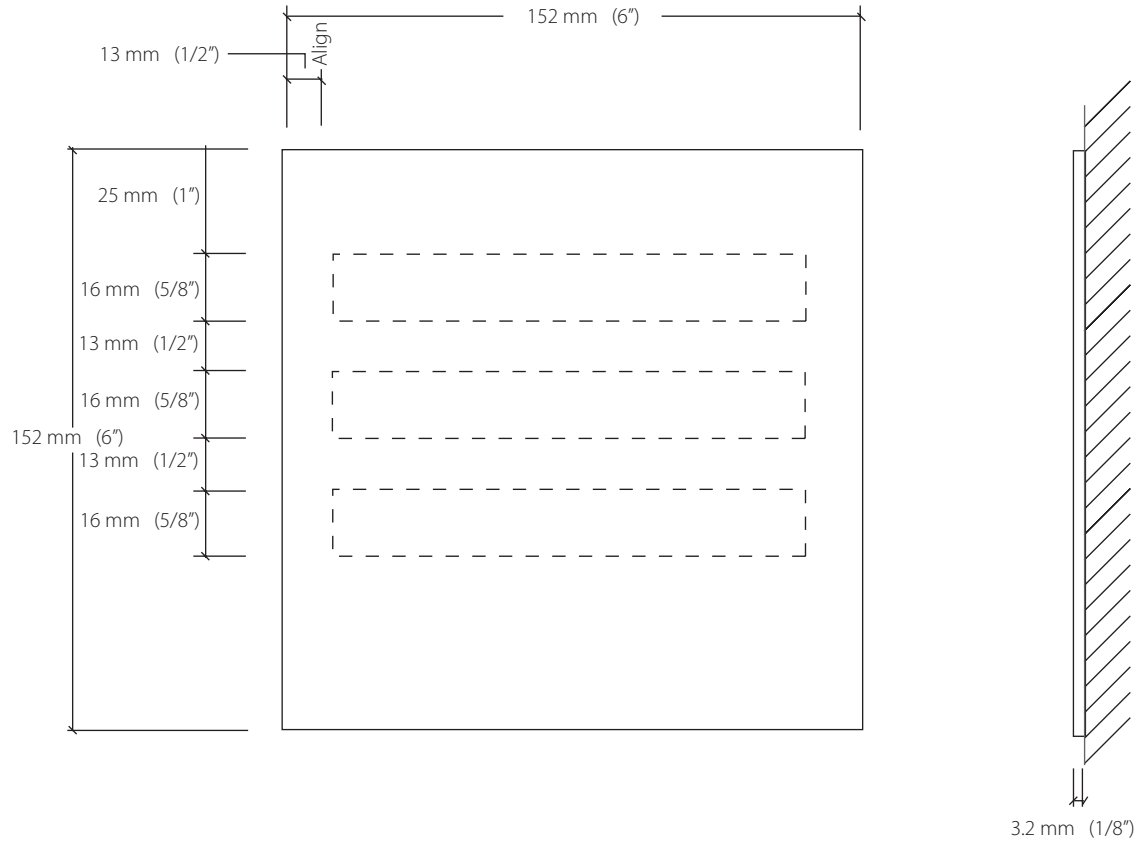
Installation

On wall 6" above automatic door opening button.

Recommendations

These signs help bring attention and provide direction to doors with automatic opening capability.





The specifications for interior signs are available in the Master Construction Specifications area of the VA Technical Information Library.

http://www.va.gov/facmgt/standard/spec_10.asp

Refer to Specification 10440.

For more information regarding specifications, contact the Office of Facilities Management, Standards Service.

The specifications will require editing to eliminate signs that are not needed and to adapt the specifications to the specific project for which they are intended.

The specifications require close coordination taking into account the existing sign program at a medical center, sign maintenance and future signing needs.

The sign message schedule is considered a part of the specifications and would comprise the last section. Configuration of the message schedule may vary according to project requirements.

The sign message schedule form, illustrated in the Programming Section of this Handbook, lists the typical information that a sign manufacturer and installer will require.

The sign message schedule needs to be coordinated with a sign location plan drawing showing where signs are to be placed within a building or on the site. See the example in the Programming Section of this Handbook.

The type of interior sign and sign system being selected for a particular application or facility may require several decisions and involve different construction and assembly components to meet the desired requirements. This section provides an overview of the intended criteria for interior sign programs.

Many sign manufacturers currently market extrusions, standard parts and component sign systems that will accomplish the illustrated objectives of the intended interior sign system. These extruded, molded and fabricated component sign systems are acceptable so long as the illustrated and stated specifications are adhered to.

The acrylic interior sign program, that has been in place since 1980, is a program that can be replaced with a component system. This is a sign program that brings new products and solutions to meet various needs of the medical centers. Component systems are available from GSA sign manufacturers and sign manufacturers in the open market place.

The details showing the construction of the sign component system sign types are based on a concept of a component system. The illustrations are intended to show the desired configuration and intent of the various sign types. Sections of the extrusions and various parts are for illustration purposes and have not been engineered or configured for extruding and do not represent a finished form.

With the component system, variations such as beveled and radius shapes in the accent rails and end caps are not shapes that conform to the sign program. Elimination of radius corners reduces costs, provides more flexibility and allow inter-changing of components.

Once a component system is selected, it should eventually become the standard for the facility. The component system has been designed to be compatible with an existing old style acrylic system in size, however there will be a significant difference in appearance.

Both systems encourage the ongoing updating and maintenance of the sign program to be done by the facility. The component system uses vinyl letters or silk screened letters as the method of producing the lettering. Engraving can also be used, but this increases the costs of the signs and the added cost does not provide significant benefits.

The Specification section of the Guide should be read in conjunction with the Construction Details section. This will provide an overview of the interior sign construction requirements, materials and finishes.

The guide illustrates component based sign systems for certain sign type families. These families are Type 03, 04, 05, 06, 07, 11, 12, 13, 14, 15, 16 and 17.

Component systems use various interlocking elements which, when assembled, create a sign. They are available from several manufacturers and these general illustrations represent component systems that slide or snap together.

A benefit of the component system is that it provides flexibility and simplicity in maintaining and adapting signs to ever changing needs. Components from one sign can be interchanged with components from another sign quickly and easily. Existing signs can be added to or modified to perform another function.

Changing directional signs is simple. Adding new text and arrows and rearranging messages is always possible.

While component signs can be installed along side old style acrylic signs, they will appear slightly different. Also, elements of the component system along with several of its benefits are not interchangeable with the acrylic system.

Implementation of a component system requires commitment to that specific manufacturers system. Review carefully the advantages and disadvantages of various components systems from different manufacturers and talk to facilities that have installed the system that is being considered.

In the following pages, the guide illustrates the sliding rail component system to show how it would apply to the various sign type applications. Other systems may equally apply.

Sliding Rail Component System

The sliding rail component system uses various interlocking elements that slide together to create a sign.



Snap Rail Component System

The snap rail component system uses various interlocking elements that snap together to create a sign.



Injected Molded Component System

This component system uses molded plastic pieces that snap together to create a sign.



**Exclusions
Frames & Radius
Corners**

Frames for interior signs are no longer a part of the sign program.

This applies to both thin and thick plastic and aluminum frames.

Radius corner signs and radius corner frames are also not included in the sign program.

Frames have been dropped from the interior sign program for several reasons:

- They significantly increase the cost of signs
- They create difficulties when inserting and removing inserts
- Frames from different manufacturers are not compatible with inserts from different companies
- Frames are quite thick and create a “dirt catching shelf”
- Frames from different manufacturers have such varied “looks” that this creates a disorganized appearance within a medical center.

Radius corners plaques are not a part of the program because they create compatibility problems when trying to maintain a sign program over several years using different manufacturers as suppliers. Radius corner framed plaques are worse and create even more compatibility problems.

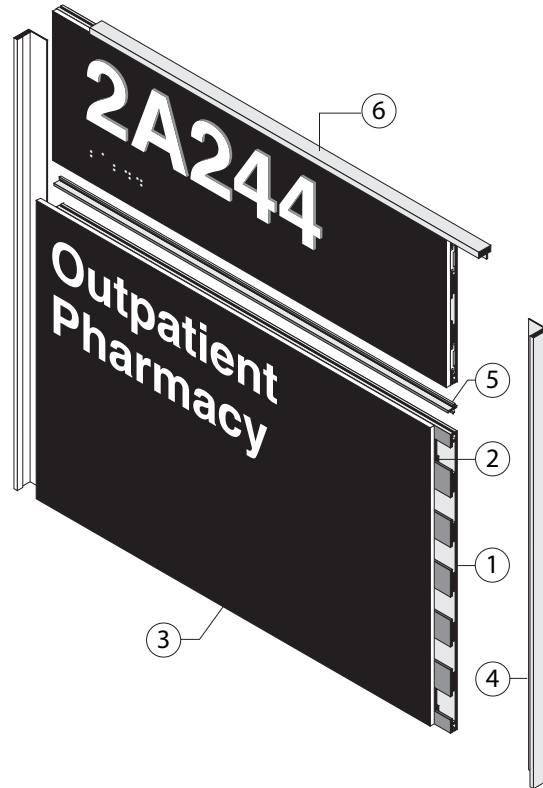
If a facility has square corner frames, radius corner frames or radius corner plaques as a part of the current program, that element of the program can be continued if continuity is desired.



Detail 1

Sliding Rail Component System
Type IN03 & IN04.1
Room Identification Sign
Comprised of the following components:

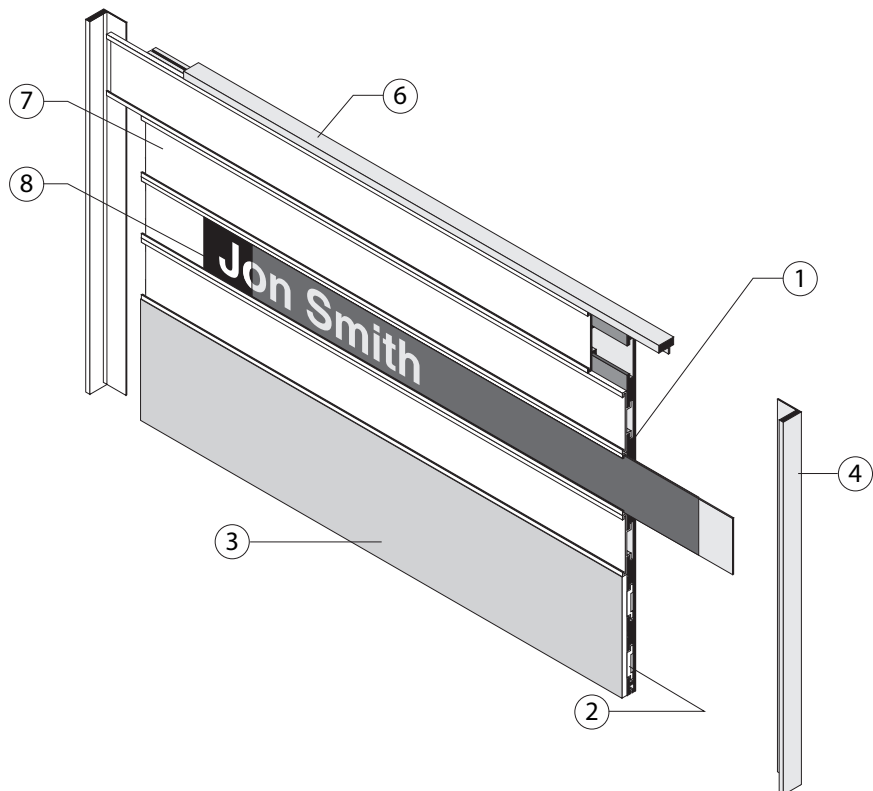
- 1** A Sliding Rail Back utilizing horizontal grooves which are spaced to allow for uniform, modular sizing of sign types.
- 2** An Insert that mounts to the back of the Copy Panels to allow for attachment to Sliding Rail Back by sliding in horizontally from either side.
- 3** Copy Panel which can be made of a variety of materials to allow for different graphic needs.
- 4** End Caps which interlock to form an integral unit, enclosing and securing the changeable Copy Panels to the back.
- 5** Joiners and Accent Joiners that connect separate Sliding Rail Backs together. For example, a Joiner connects a Type IN03 sign to a IN04.1 sign.
- 6** Accent Bar which provides a 3 mm (.125") high decorative trim cap enclosing the top of the sign.



Detail 2

Sliding Rail Component System
Type IN05.1
Patient Room Sign
Comprised of the following components: (see Detail 1 for descriptions of items 1-6)

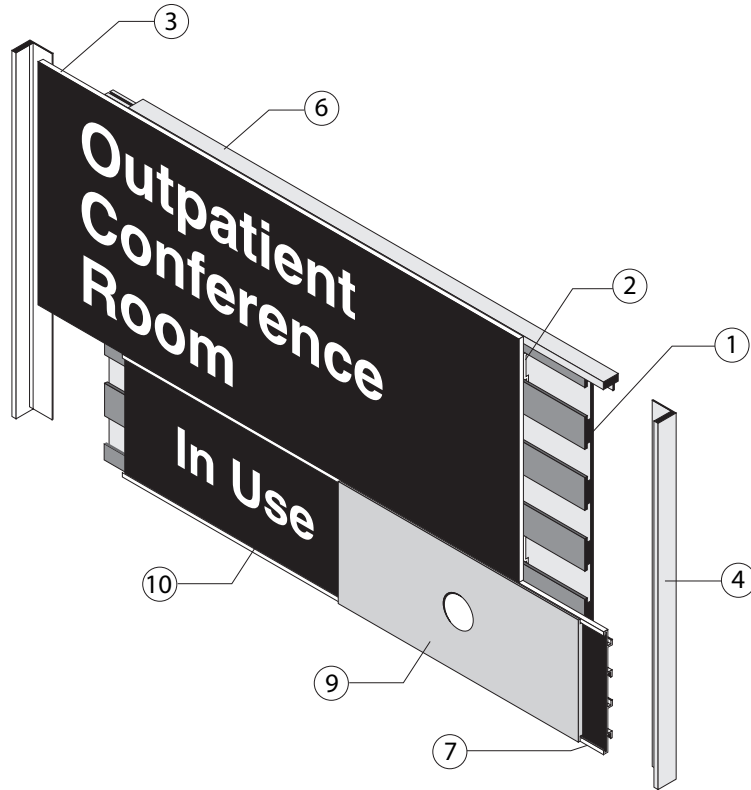
- 7** Extruded Insert Holder with integral rail grooves for connection with Sliding Rail Back.
- 8** Paper Copy Insert behind a clear textured polycarbonate cover.



Detail 3

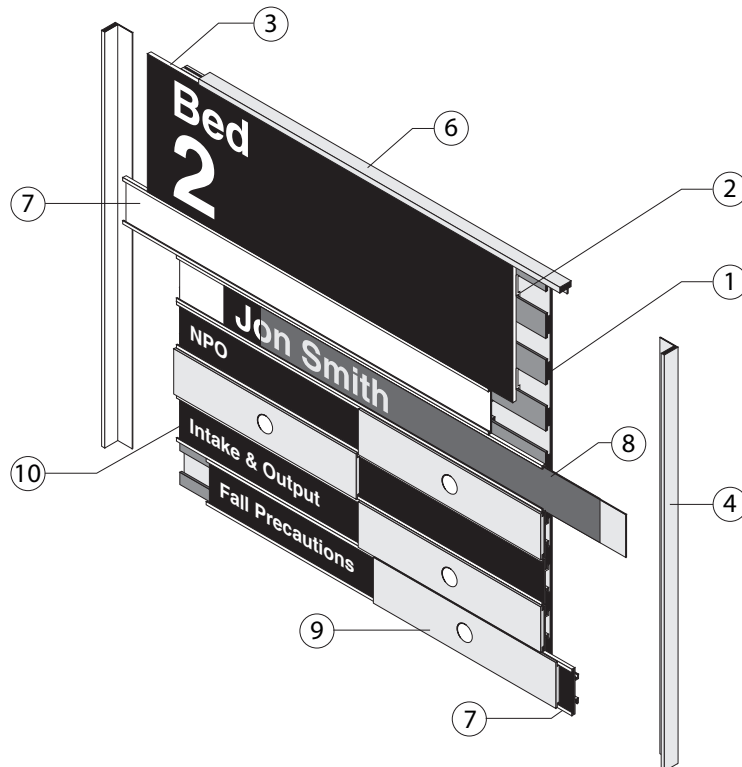
Component System
Type IN07.1
Conference, Exam or Treatment
Room Sign Comprised of the fol-
lowing components: (see Details
1&3 for descriptions of items 1-7)

- 9 Metal slider mounts in the Insert
Holder and slides horizontally.
- 10 Polycarbonate Insert with
subsurface copy and color.



Detail 4

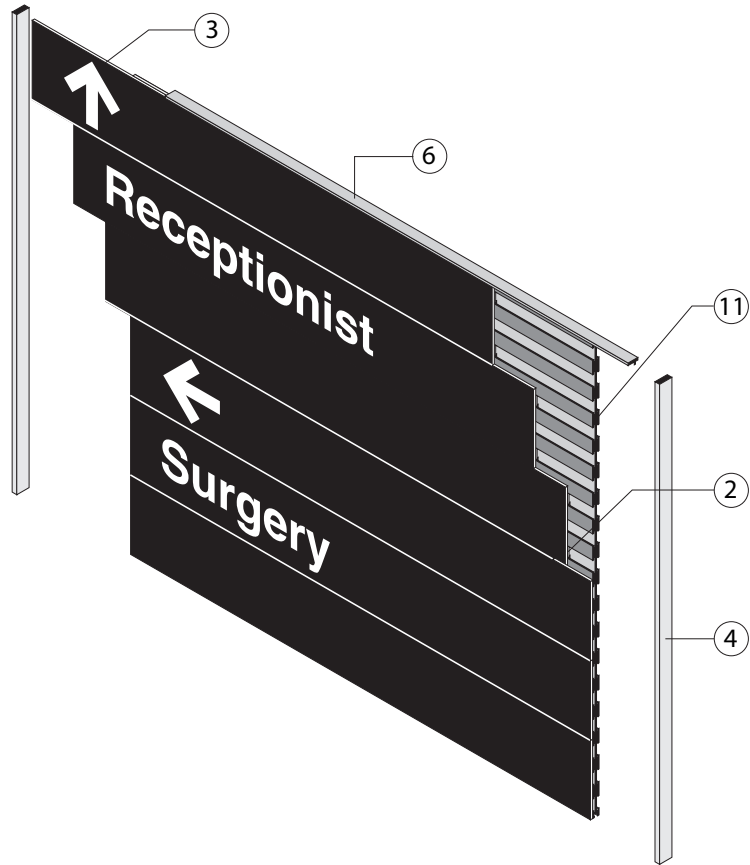
Component System
Type IN06.2
Patient Bed Sign Comprised of the
following components: (see Details
1, 3 & 5 for descriptions of items
1-10).



Detail 5

Component System
Type IN14
Wall Directional Sign Comprised of the following components:
(see Detail 1 for descriptions of items 1-6)

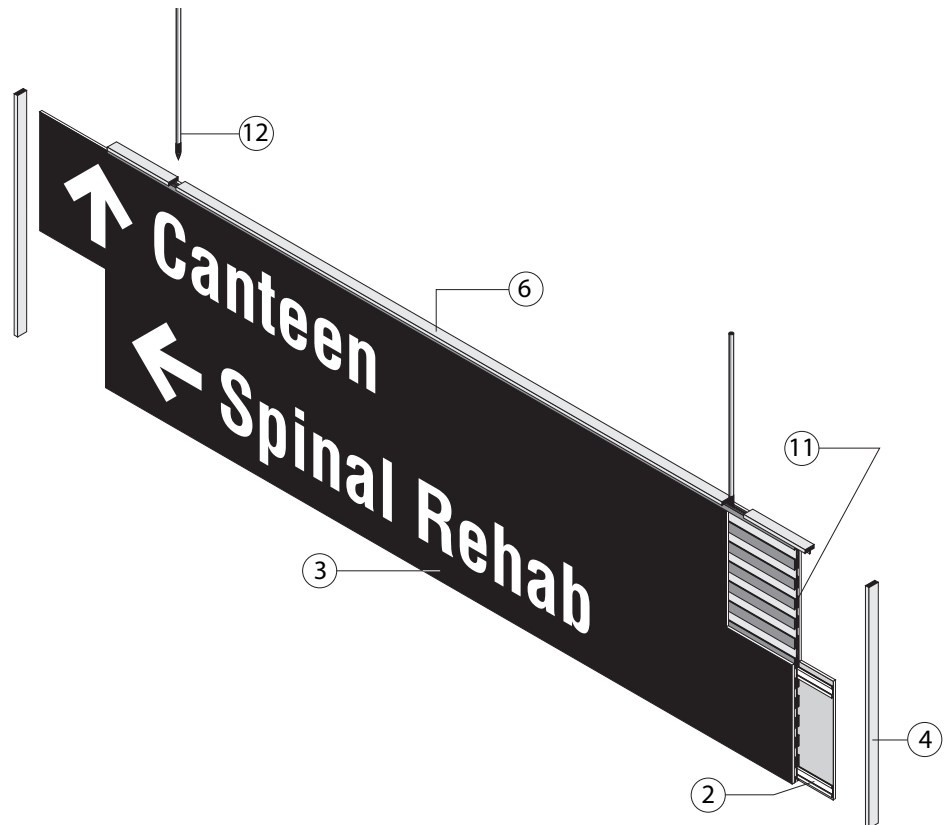
11 A double sided Structural Rail Back Panel utilizing horizontal rails which are spaced to allow for uniform, modular sizing of sign types.



Detail 6

Component System
Type IN15 & IN16
Ceiling Mount Sign Comprised of the following components:
(see Details 1, 9 for descriptions of items 1-6, 11)

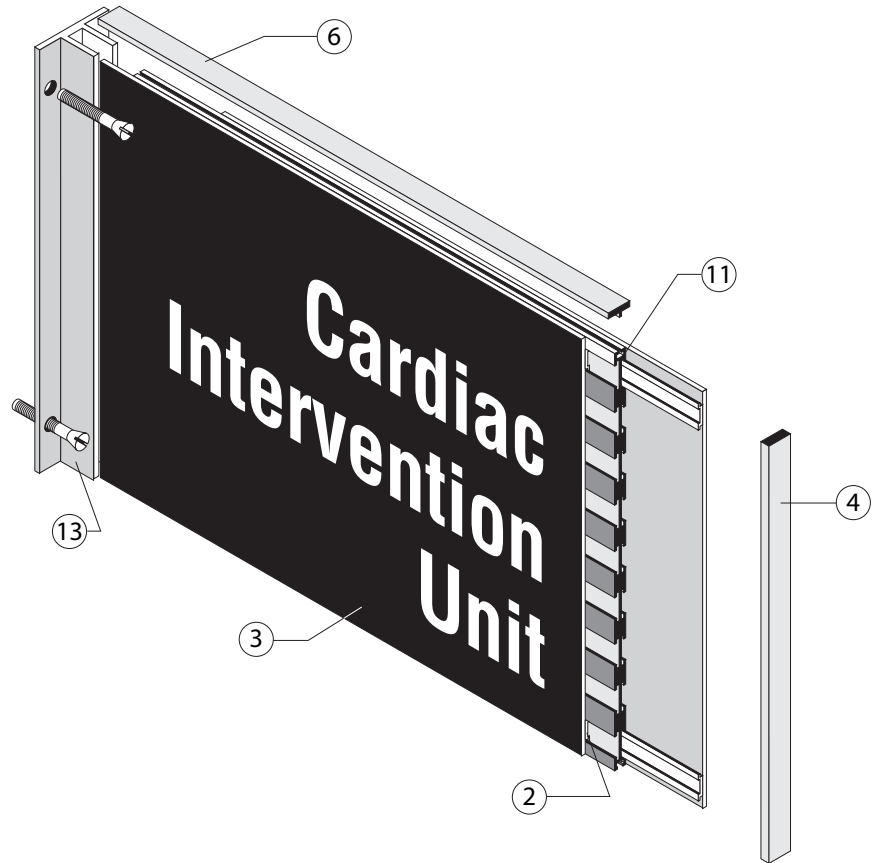
12 A rod or braided stainless steel cable for attachment to the ceiling.



Detail 7

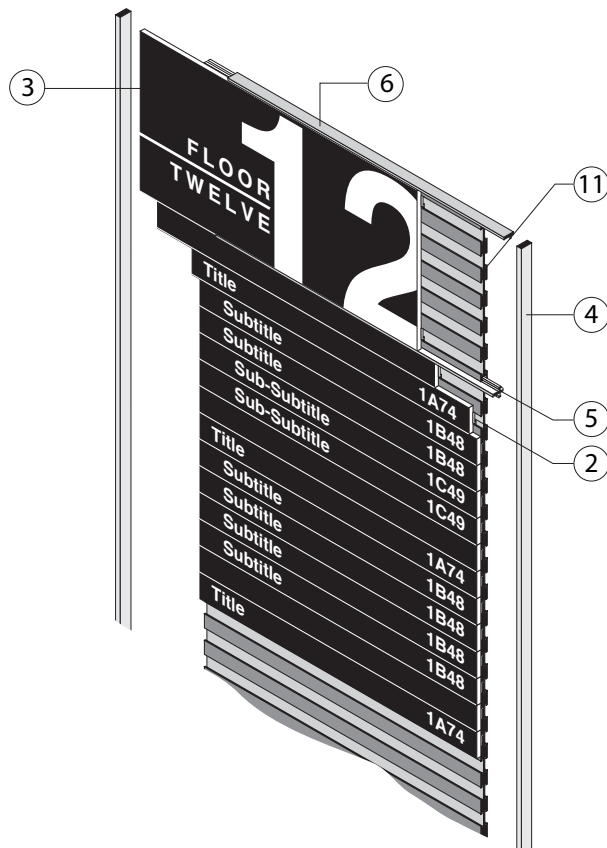
Component System
Type IN13
Perpendicular (flag) Mount Sign
Comprised of the following
components: (see Details 1, 9 for
descriptions of items 1-6, 11)

13 Extruded aluminum Mounting
Bracket.



Detail 8

Component System
Type IN15
Directory Comprised of the follow-
ing components: (see Details 1, 9
for descriptions of items 1-6, 11)



Detail 9

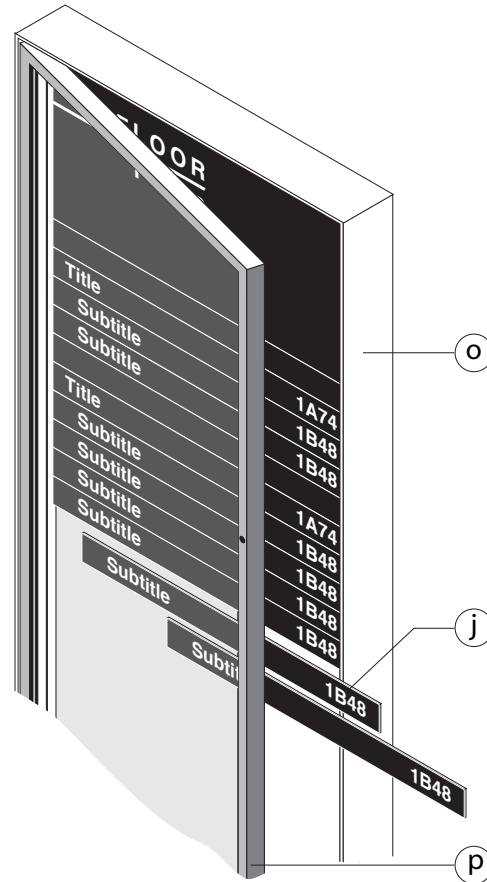
Acrylic System

Type IA16

Directory Comprised of the following components: (see Detail 10 for a description of item j)

o An extruded aluminum Directory Case Frame shaped to hold a hinged door and retain copy strips

p Extruded aluminum Door Frame shaped to hold gasketed double strength glass, hinge and fit within the Directory Case Frame. Door shall contain a key lock for closure.



Detail 10

Sign Frame

Type IA03, IA04.1 & IN10

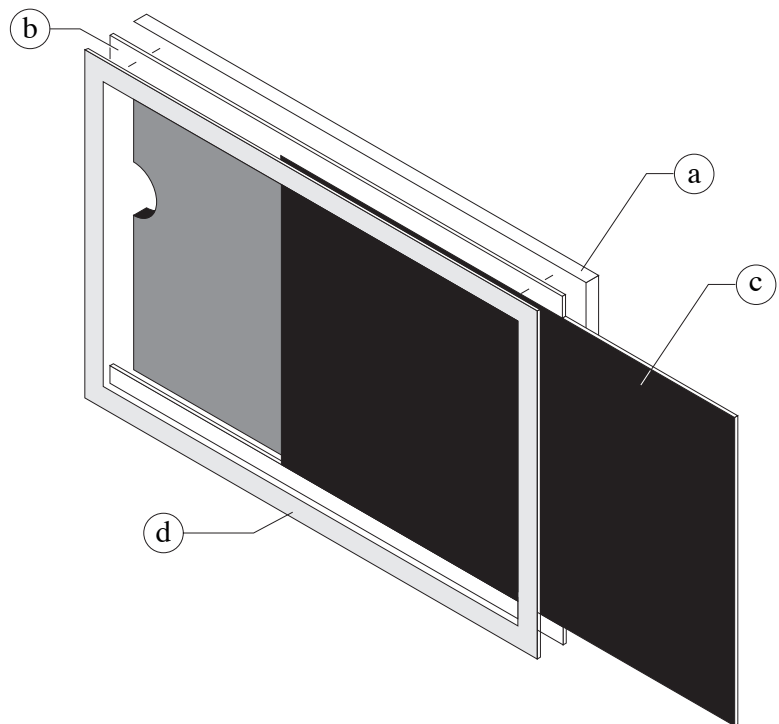
Comprised of the following components:

a A Back Plaque

b Spacers to allow for insertion of Copy Inserts by sliding them in horizontally from either side.

c Copy Inserts which can be made of a variety of materials to allow for different graphic needs.

d Face Plaque made of non-glare, optically clear acrylic that will allow clear reading of Copy Insert text. The Face Plaque is to have a second surface (sub-surface) color applied border to create a window.



The installation of interior signs requires coordination of several interlaced criteria. Interior signs, especially directional signs, require coordination and careful consideration of the following:

- Criteria**
- Location of building entrances and elevators.
 - Configuration of the corridor system.
 - Desired path of travel within the building for visitors, patients and employees.
 - Location of departments and clinics.
 - A simple clear room numbering system that follows a clear, understandable pattern.
 - Adequate light on and around directional signs.
 - Placement of signs in locations where people are expecting them to be.

Visibility These elements help establish the basis of a clear sign program that communicates and informs in a direct and simple manner.

Interior signs function to communicate to both patients and visitors as well a staff. Their placements need to be planned relative to the intended viewer, particularly directional signs. Sign visibility to the intended user is a principal objective that is the basis of correct sign placement.

Placement Proper sign placement is part of a well-planned interior sign program.

In order to meet ADA guidelines, tactile room number signs must now always be specifically placed on the wall, on the strike/knob side of the door. Ceiling mounted signs require larger lettering size so only short selective message can be communicated. Interior directional signs are intended to communicate directions to visitors and patients and their placement needs to be planned relative to the intended viewer. Sign visibility to the user is a principal objective that is the basis of correct sign placement.

Correct placement of signs will usually mean that fewer signs are required. Too many signs can create a cluttered appearance and increase the difficulty for a viewer to find the particular information they are seeking. Placement of signs where there is sufficient lighting is critical. Care also needs to be taken to place signs in a manner that allow clear viewing.

Colors need to be considered as well, as this has an effect the visibility of signs. Putting directional signs in a color that is different from room identification signs can be helpful to patients and visitors.

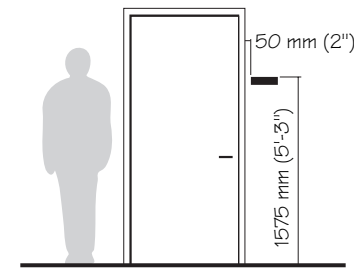
Planning A sign program for a building, that works well, is one that has been planned as an integrated whole. All the way from the main entrance sign, to directional signs, room identification signs, informational signs, code required signs and life safety signs.

Detail 1

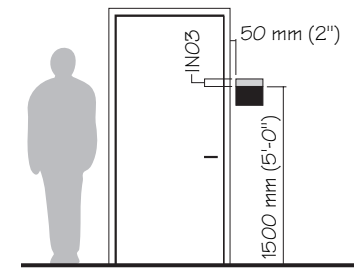
Installation detail sign type 03, building standard, room number.

Detail 2

Installation detail sign types 04.1, 04.2, 05.1, 05.2, 05.3, 05.4, 07.1, 07.2, 07.3. Building standard room number and name.



Detail 1



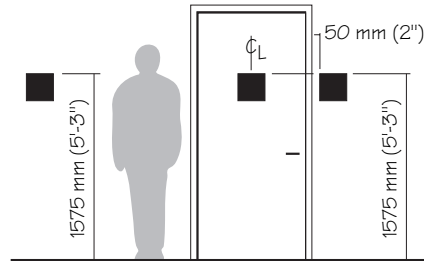
Detail 2

Detail 3

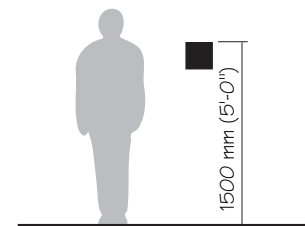
Installation detail sign types 08.1, 08.2, 08.3, 08.4, 09.1, 09.2, 09.3, 09.4, 09.5, 09.6, 09.7, 09.8, 09.9, 09.10, 09.11, 09.12, 09.13, 11.1, 11.2. Building standard.

Detail 4

Installation detail sign types 10.4, 10.5, 10.6.



Detail 3



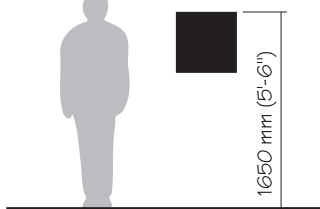
Detail 4

Detail 5

Installation detail sign types 10.2, 10.3, 11.3, 14.4, 14.5

Detail 6

Installation detail sign types 10.1, 14.1, 14.2, 17.1, 17.2, 17.3, 17.4.



Detail 5



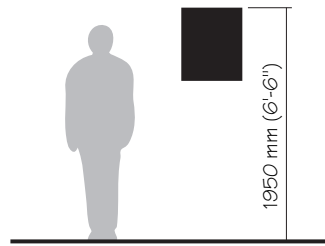
Detail 6

Detail 7

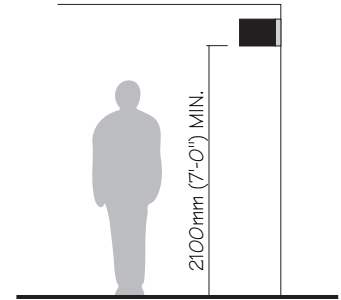
Installation detail sign types 14.3

Detail 8

Installation detail sign types 13



Detail 7



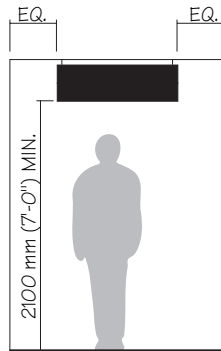
Detail 8

Detail 9

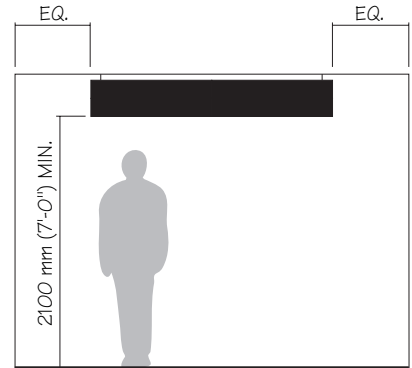
Installation detail sign types 15.1, 15.2, 15.3, 15.4, 16.1, 16.2, 16.3, 16.4.

Detail 10

Installation detail sign types 15.5, 15.6, 15.7, 15.8, 16.5, 16.6, 16.7, 16.8.



Detail 9



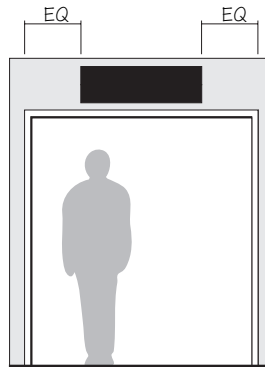
Detail 10

Detail 11

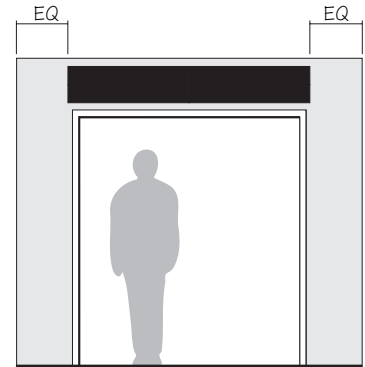
Installation detail sign types 15.1, 15.2, 15.3, 15.4, 16.1, 16.2, 16.3, 16.4.

Detail 12

Installation detail sign types 15.5, 15.6, 15.7, 15.8, 16.5, 16.6, 16.7, 16.8.



Detail 11



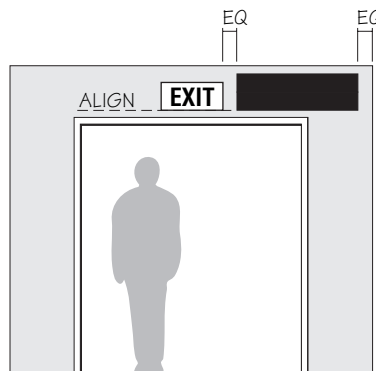
Detail 12

Detail 13

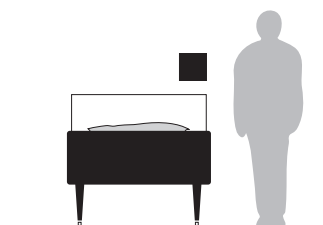
Installation detail sign types 15.1, 15.2, 15.3, 15.4, 16.1, 16.2, 16.3, 16.4.

Detail 14

Installation detail sign types 06.1, 06.2, 06.3.



Detail 13



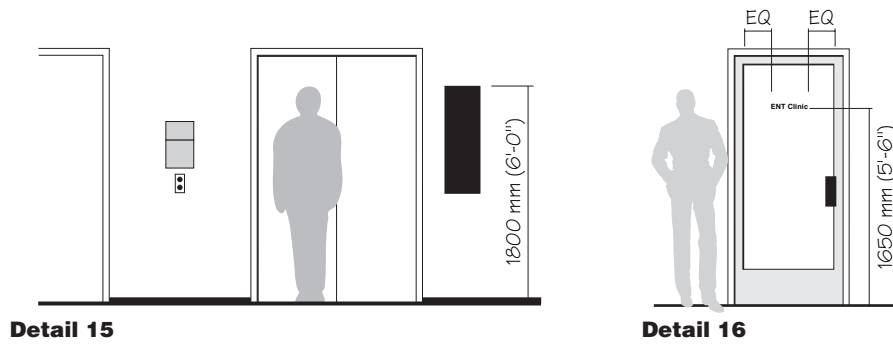
Detail 14

Detail 15

Installation detail sign types 17.5, 17.6.

Detail 16

Installation detail sign type 18



Detail 17

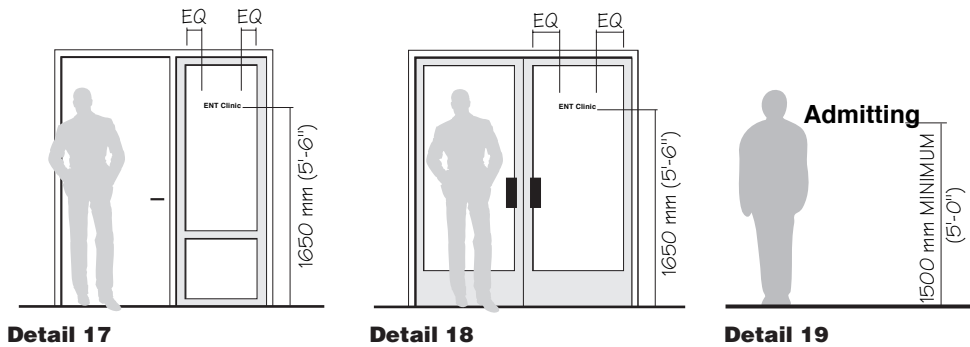
Installation detail sign type 18

Detail 18

Installation detail sign type 18

Detail 19

Installation detail sign types 19.1, 19.2, 19.3.

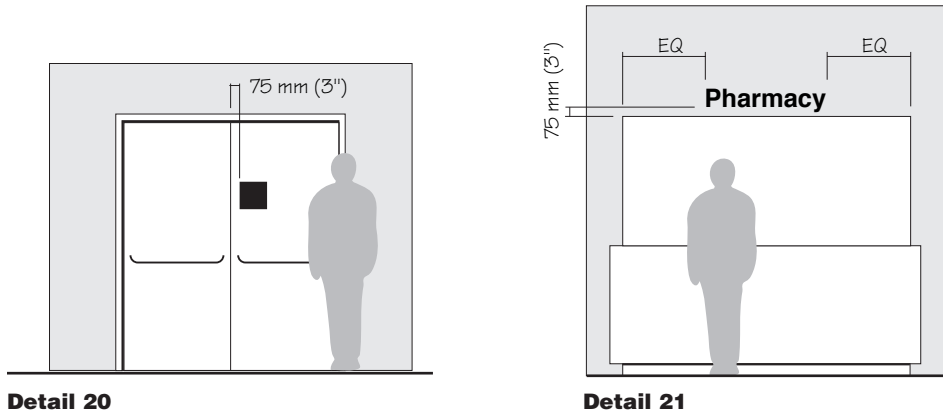


Detail 20

Installation detail sign types 08.2, 08.3, 08.4

Detail 21

Installation detail sign type 19.1, 19.2, 19.3.

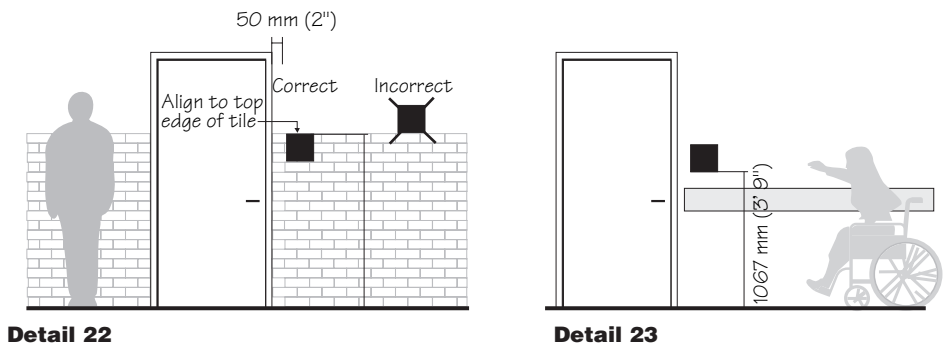


Detail 22

Tile wainscot wall installation guide for room identification signs.

Detail 23

Room identification sign installation guide for Spinal Rehabilitation and Nursing Home facilities.

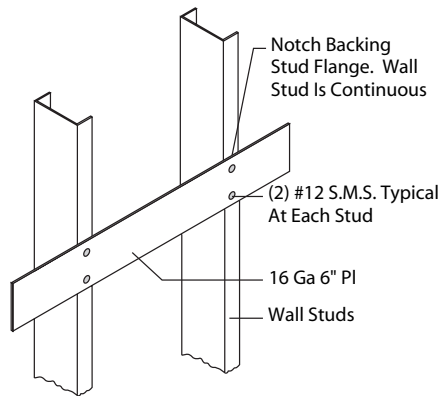


Wall Mounted Sign Detail

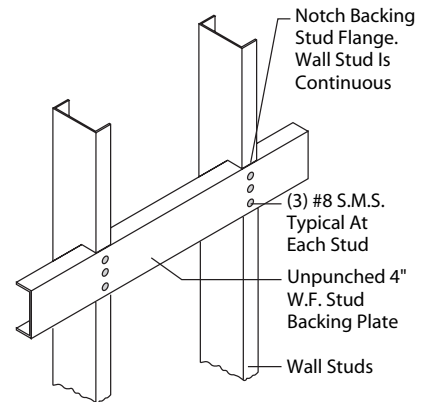
Interior wall bracing for heavy signs, directories, cast plaques, etc.

Stud Backing Plate A Ê

- 1 Max Weight- 25 lbs. point load. If sign load exceeds this use Stud Backing Plate B.
- 2 Attach plates to 3 studs min.
- 3 Verify length, height, location & number required.
- 4 Use #12 Self Tapping Screws when attaching items to backing, U.O.N.



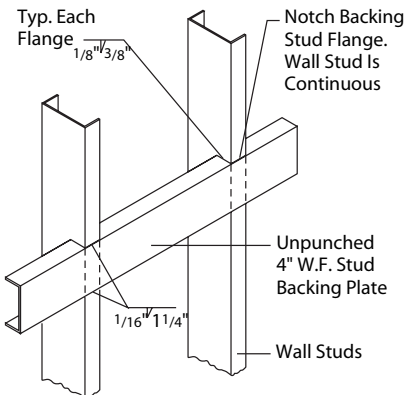
Stud Backing Plate A



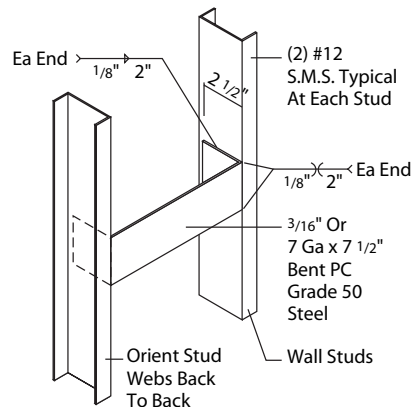
Stud Backing Plate B

Stud Backing Plate B Ê

- 1 Max Weight- 50 lbs. point load. If sign load exceeds this use Stud Backing Plate C.
- 2 Attach plates to 3 studs min.
- 3 Verify length, height, location & number required.
- 4 Use double stud when stud is supporting more than 2 backing plates



Stud Backing Plate C



Stud Backing Plate D

Stud Backing Plate C Ê

- 1 Max Weight- 200 lbs./ft.
- 2 Attach plates to 3 studs min.
- 3 Verify length, height, location & number required.
- 4 Use double stud when stud is supporting more than 2 backing plates.

Stud Backing Plate D Ê

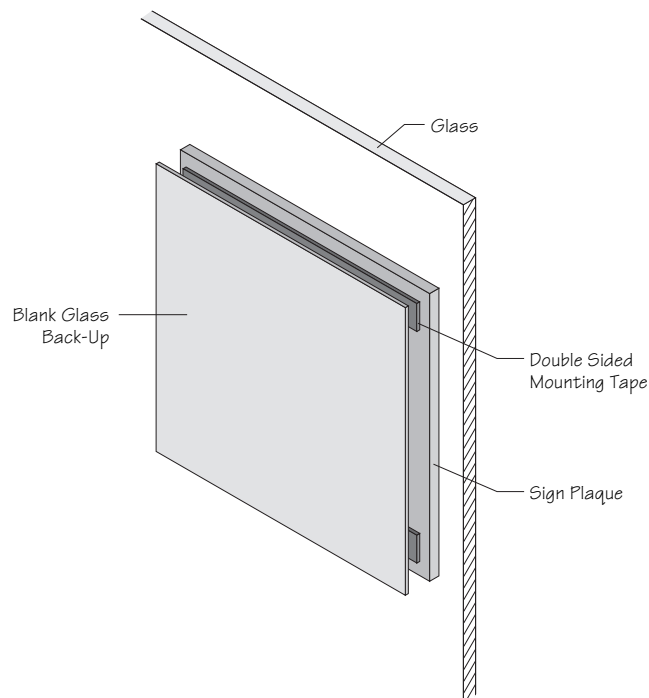
- 1 Max Weight- 300 lbs. point load.
- 2 Attach plates to 3 studs min.
- 3 Verify length, height, location & number required.

Glass Back Up

Certain signs may require that they be installed on glass because there is no available wall surface.

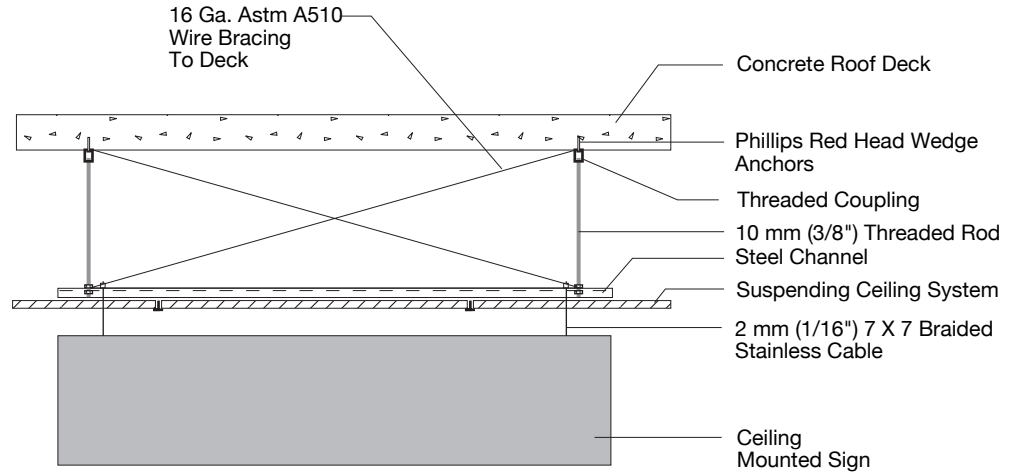
When this situation occurs, a blank glass back up is required to be placed on opposite side of glass exactly behind sign being installed.

This blank opaque glass back up is to be the same size and color as the sign being installed so it effectively covers and hides the mounting of the sign to the glass.

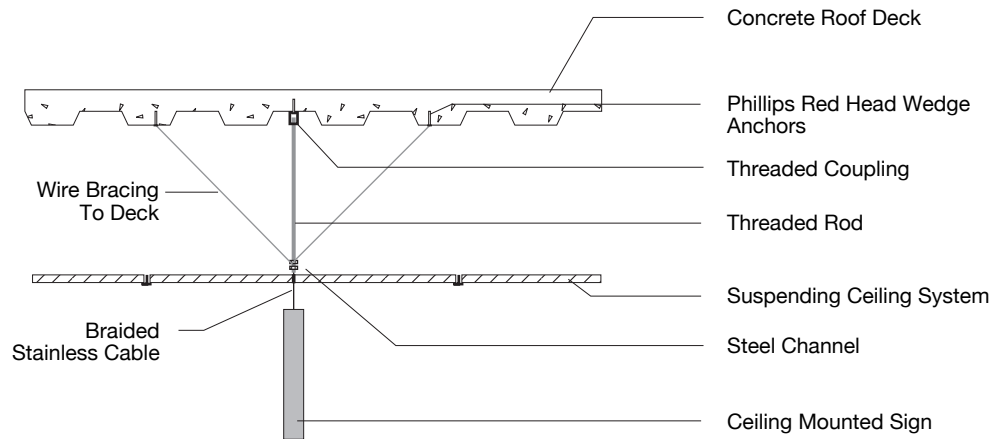


Ceiling Mounted Sign Detail

Use for signs that weigh over 20 lbs. and are mounted from a suspended ceiling system.



Front View



Side View

TAB 2
VA EXISTING ASBESTOS SURVEY



CORPORATION - MICHIGAN

phone: 989.753.5599 fax: 989.753.3119 3515 Janes Ave., Suite 1 Saginaw, MI 48601 www.misenv.com

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VA ANN ARBOR MEDICAL CENTER

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Performed by: MIS Corporation - Michigan
Ted Allen: A8654
Louis Laframboise: A10684

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Floor Plans.....	16 pages



phone: 989.753.5599 fax: 989.753.3119 3515 Janes Ave., Suite 1 Saginaw, MI 48601 www.misenv.com

INTRODUCTION

The attached Asbestos Survey and Assessment report has been prepared for the Veterans Administration Ann Arbor Medical Center located at 2215 Fuller Road, Ann Arbor, MI. The reassessment was conducted by MIS Corporation – Michigan during November & December 2009 and February 17, 2010 by State of Michigan accredited building inspectors Ted Allen (A8654), Louis Laframboise (A10684) and Anne Schultz (A1880). The buildings covered in this updated survey are:

Building #	Year Built	Building Name	Total Gross Square Foot
01	1953	Main Hospital & Additions	449,693
02	1942	Day Care Center & 1993 Addition	4,420
03	1953	Administrative Offices	8,673
04	1953	Administrative Offices	6,309
22	1971	Research Building & 1988 Addition	17,630
28	1985	Extended Care Center	58,900

The VA Medical Center occupies all of these buildings.

PURPOSE AND SCOPE OF WORK

Under a VA mandate, the asbestos survey needs to be updated every three years. The asbestos building inspectors were briefed on the scope of the project by Mr. Joe Jurasek – VA Ann Arbor Medical Center Safety Department. The purpose of this reinspection was to verify which of the previously identified asbestos-containing materials (ACM) were still present and to verify the quantity and condition of the materials. All of the previously identified rooms/spaces were examined, as well as areas where asbestos abatement had occurred to verify the completeness of the abatement.

On the 8th floor of the Main Hospital, the hearing test booths were unoccupied and available for destructive asbestos testing of suspect materials that could be present within the walls, ceilings, floors and door cavities. Either fiberglass insulation or solid metal composed the walls, floor and ceiling of the test booths. The four hearing test booths are located near room B816 in the North Wing of the hospital. Two of the booths are 6' x 8' and the other two are 8'x8' with an access door that is 3' x 6' for each booth.

Suspect materials that were found in the construction of the hearing test booths are as follows:

1. White pliable caulk in the side panels along the edge of the fiberglass insulation within the walls (HA 291)
2. Tight woven expansion cloth between the booths (HA 292)
3. Felt gasket between the walls and ceiling of the booths (HA 293)
4. Gray powdery board inside the door (HA 294)

**VA Ann Arbor Medical Center
2010 Asbestos Survey Assessment**

Building 22 penthouse was treated as a new area and all suspect materials were assigned new homogeneous numbers and sampled.

Suspect materials that were identified and sampled following EPA protocol are the following:

1. Suspect Debris on Floor (HA 290)
2. Black Tar Paper on Pipe (HA 295)
3. Silver Putty on Ductwork (HA 296)
4. Light Brown Putty on Ductwork (HA 297)
5. White Sprayed-on (HA 298)
6. Heavy Weave Expansion Joint (HA 299)
7. Black Rubberized Expansion Joint (HA 300)
8. Silver Rubberized Expansion Joint (HA 301)
9. Canvas over Fiberglass Duct Insulation (HA 302)
10. City Water Line, Mud Fittings, <2" on Fiberglass Straight (HA 303)
11. Abandoned Line, Mud Fittings, <2" on Fiberglass Straight (HA 304)
12. Steam Line, >2" - <4" Preformed Straight Run Pipe Insulation (HA 305)
13. Steam Line Mud Fittings, >2" - <4" Preformed Straight Run Pipe Insulation (HA 306)
14. Steam Line, Mud Fittings, <2" on Fiberglass Straight (HA 307)
15. Condensate Line, Mud Fittings, <2" on Fiberglass Straight (HA 308)
16. Condensate Tank, Mud over Fiberglass (HA 309)
17. Heat Exchanger, Mud over Fiberglass (HA 310)
18. Hot Water Supply-Return Tank, Mud over Fiberglass (HA 311)
19. Hot Water Supply-Return Line Mud Fittings, <2" on Fiberglass Straight (HA 312)

The homogeneous area lists have been updated to include these new numbers.

Three bulk samples of each of these materials were collected by the MIS inspectors. The materials were double bagged and assigned unique sample numbers prior to being submitted to an accredited laboratory (Environmental Hazards Services, L.L.C. (EHS)) for asbestos determination using polarized light microscopy (PLM). Quality Control samples were also submitted to Kevco Services. The sample locator has been amended to include these new samples along with the lab reports.

RESULTS OF SURVEY AND ASSESSMENT OF ACM

Six of the 23 homogeneous areas were found to contain asbestos fibers. All of these samples were located in the penthouse of Building 22. These new positive HA are:

- HA 297 - Light Brown Putty on Ductwork
- HA 298 - White Sprayed-on
- HA 290 - Heavy Weave Expansion Joint
- HA 305 - Steam Line, >2" - <4" Preformed Straight Run Pipe Insulation
- HA 306 - Steam Line Mud Fittings, >2" - <4" Preformed Straight Run Pipe Insulation
- HA 311 - Hot Water Supply-Return Tank, Mud over Fiberglass

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The ACM inventory sheets have been amended to include these materials.

Extensive renovation projects have occurred since the original asbestos survey was conducted in 1995 that have involved substantial asbestos abatement within their scope of work as well as maintenance activities that involved limited abatement. Within the last three years limited asbestos abatement has occurred with the majority being removal of asbestos floor tile and mastic. A summary of the major renovations within Building 1 – Main Hospital entailed the following areas:

- 1st floor of the Main Hospital East-West Wings have been renovated and asbestos abatement has occurred in those areas.
- 2nd floor the entire East-West Wings have been abated and renovated.
- 3rd floor the East-West Wings have been renovated and extensive asbestos abatement has occurred.
- The entire 4th floor of the Main Hospital has been renovated and the asbestos-containing materials have been removed.
- The entire 5th floor along with the Mechanical Room has been abated of ACM.
- 6th floor the entire East-West Wings have been abated along with all of the floor tile and mastic in the corridors.
- 7th floor the entire East-West Wings have been abated.
- 8th floor East-West Wings have been renovated and asbestos abatement has occurred in those areas.
- 9th floor has had limited asbestos abatement in areas.
- 10th floor Penthouses have residual ACM present.

Since the majority of the TSI is found above ceilings or other relatively inaccessible areas, disturbance of TSI by medical staff, patients and visitors is unlikely. The limited asbestos-containing sprayed-on insulation located on some structural beams on the 8th floor North Wing of the Main Hospital is also above ceiling tiles. Care needs to be exercised when working above these areas. When lifting ceiling tiles in areas where debris is noted or in the area of the sprayed-on insulation precautions need to be taken to prevent further disturbance of the accumulated ACM debris.

Floor tiles that contain asbestos are found throughout the hospital in patient rooms, corridors, treatment rooms, offices, storage areas and closets. All but the offices and storage areas see fairly heavy traffic; in all cases the flooring is in good condition. Maintenance personnel should follow the requirements for floor maintenance outlined in OSHA's revised asbestos regulations, 29 CFR 1926.1101(l)(3). Additional requirements under EPA NESHAPS/OSHA need to be followed if/when floor coverings are removed during building renovation or demolition.

Physical Assessment Considerations

The standard AHERA Assessment Categories (40 CFR 763.88(b)) were used as follows:

- 1 Damaged or significantly damaged thermal system insulation ACM.
- 2 Damaged friable surfacing ACM.
- 3 Significantly damaged friable surfacing ACM.

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- 4 Damaged or significantly damaged friable miscellaneous ACM.
- 5 ACBM with potential for damage.
- 6 ACBM with potential for significant damage.
- 7 Any remaining friable ACBM or friable suspected ACBM.

ACM Debris: ACM debris is present on the floor in Bldg. 1 basement level room BB55 behind the shelves. Debris was still present on the back surfaces of ceiling tiles in several areas and is listed in the Room Inventory Log. In Bldg. 1, second floor the area was given a higher response category due to high air movement within the ceiling plenum. Areas with debris should be cleaned up using the requirements of OSHA 29 CFR 1926.1101 (l) (4).

TSI: Thermal system insulation (TSI) is in good condition overall. Areas with damage have been noted in the Room Inventory Log in the comments section and assigned a higher response category. Remediation of these conditions is recommended. All ACM TSI should be included in the VA Ann Arbor Medical Center O & M Program.

Surfacing Materials (SM): Sprayed-on ACM is found only on the 8th floor North Wing of the Main Hospital applied on structural beams located above ceiling tiles. There are only four separate areas and in some cases the beam has been enclosed in drywall. The plaster in Building 3 is in good condition with only one area showing signs of damage. These areas need to be included in the owner's O & M Program.

Floor Coverings & Mastics: All floor covering is in good condition. Any damaged tiles have been sealed with floor wax. Flooring materials were found to be non-friable in the inspected areas of the VA Ann Arbor Medical Center. Maintenance and housekeeping personnel need to be informed where these tiles are located and follow the floor care procedures outlined in asbestos regulations as stated above.

Transite: These materials are in good condition and considered non-friable. Prior to any renovation projects that would impact these materials or demolition of the building these materials need to be removed.

RECOMMENDED RESPONSE ACTION

Response Categories were assigned to each asbestos-containing homogeneous area from the following:

- 1 Significantly damaged ACM; exposed, friable ACM; ACM that has been or is likely to be disturbed and/or damaged, resulting in an exposure hazard to maintenance/service workers, and/or

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hospital staff and patients in the area. Category 1 areas should be scheduled for abatement as soon as possible by accredited personnel.

These are as follows:

Bldg. 1 Basement	Room BB55
Bldg. 1 2nd Floor	Room B274
Bldg. 22 Ground Level	Stair #1

- 2 Damaged ACM in areas with limited access above ceilings, behind access panels, in pipe chases or accessible only to maintenance and service personnel. Category 2 materials should be repaired and/or removed as soon as possible. If repaired and left in place, these materials should be included in periodic re-inspections to assess their condition. There are several areas that are category 2 located above ceiling tiles and some damaged TSI in the 10th floor penthouse and sub-basement area.

The category 2 areas above ceiling tiles are the following rooms:

Bldg. 1 Basement	Room AB03
Bldg. 1 Basement	Room AB92
Bldg. 1 Basement	Room BB30
Bldg. 1 Basement	Room BB57
Bldg. 1 Basement	Room BB86
Bldg. 1 Basement	Room BB89
Bldg. 1 Basement	Corridor to Bldg. 22
Bldg. 1 1st Floor	Room B176
Bldg. 1 1st Floor	Room B187
Bldg. 1 1st Floor	Room B188b
Bldg. 1 2nd Floor	Room B226
Bldg. 1 2nd Floor	Room B246a
Bldg. 1 2nd Floor	Room B276
Bldg. 1 2nd Floor	Room B279
Bldg. 1 2nd Floor	Corridor C206 where it meets C208
Bldg. 1 3rd Floor	Room B318
Bldg. 1 3rd Floor	Room B320
Bldg. 1 3rd Floor	Room B325
Bldg. 1 3rd Floor	Room B326
Bldg. 1 6th Floor	Room B614
Bldg. 1 6th Floor	Room B619
Bldg. 1 6th Floor	Room B634
Bldg. 1 7th Floor	Room B728
Bldg. 1 7th Floor	Corridor C707
Bldg. 1 8th Floor	Room A838
Bldg. 1 8th Floor	Room A839
Bldg. 1 8th Floor	Room A844
Bldg. 1 8th Floor	Room B818

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Bldg. 1 8th Floor	Room B819
Bldg. 1 8th Floor	Room B819a
Bldg. 1 8th Floor	Corridor C803
Bldg. 1 8th Floor	Corridor C804 near Room A854
Bldg. 1 9th Floor	Room A926
Bldg. 1 9th Floor	Corridor C902
Bldg. 3 Basement	Room 01B
Bldg. 3 Basement	Room 04
Bldg. 4 1 st Floor	Room 107
Bldg. 4 1 st Floor	Vestibule
Bldg. 4 1 st Floor	North/South Corridor
Bldg. 22 Penthouse	Sprayed-on and ACM Steam Pipe Insulation

- 3 TSI with intact coverings located in inaccessible areas or mechanical rooms. Category 3 materials should be re-inspected periodically to assess their condition and abated or repaired as changes in condition warrants.
- 4 Floor tiles and linoleum in offices, patient rooms, laboratories/workshops, storage areas and corridors. Category 4 materials need not be removed or abated. OSHA/EPA requirements for maintenance should be followed.
- 5 Other asbestos-containing materials that are generally in good condition. These materials need to be addressed prior to renovation or demolition projects that would disturb them.

Based on this asbestos assessment report, there are areas where clean-up of ACM is warranted as well as patch and repair of damaged TSI and SM. This will require the use of a licensed abatement contractor using trained and accredited personnel or the owner's personnel who have been trained in Class III operations for custodial workers in accordance with 40 CFR Part 763.92 (a)(2). All asbestos abatement work needs to follow OSHA's work practices and control methods mandated for the appropriate class of work. Additional requirements such as air monitoring and notifications may also be applicable depending on the response action.

APPENDICES

HOMOGENEOUS AREA LISTS

All of the suspect asbestos-containing materials are listed and described along with a separate tab for the positive or hot HA.

SAMPLE LOCATOR WITH LABORATORY REPORT

ROOM INVENTORY LOGS

On the pages that follow, the reader will find the inspection data in detail organized by functional area.

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Explanation of items and abbreviations used on the Room Inventory Log follows.

- Bldg/Floor/Room No. - VA Building Number, Floor number, and the room number found on the outside of the door. Within the Main Hospital the A designation notates room in the East-West Wings, the B prefix is for areas within the North Wing of the Hospital and C notates corridors. **Please note that on the 8th floor of the Main Hospital there are two corridors identified as B820 that have changed to C-B820 within the body of the inventory to designate that they are corridors.**
- Homogeneous Material Description - This column will provide the number and description of the material, which will consider such factors as size, application and color. The number and description under the heading correspond to the Homogeneous Area List.
- ACM Type - This identifies the specific asbestos containing material by type. Wiring material is classified as a miscellaneous material (MM) and non-friable category II.
- Location - Where in the room/space the wiring is located.
- Quantity - This will have the number of fixtures in the room/space in which the wiring is present.
- Unit - The type of measurement used to quantify the material.
- Response Category - See the definition or basis for the assignment as listed above.
- AHERA Assess. Category - AHERA Assessment Categories
- Comments - Any useful remarks

A separate room inventory is included with estimated asbestos abatement pricing.

FLOOR PLANS

We have included the floor plans for the various buildings that were used during the course of this assessment.

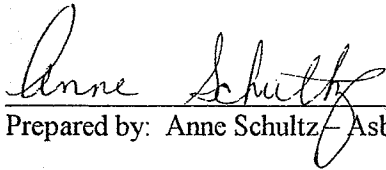
INSPECTOR ACCREDITATION

Also included in this report are copies of the State of Michigan accreditations of the inspectors utilized on the project. The inspectors that worked on the project are:

- | | |
|----------------------|--------|
| ▪ Allen Ted | A8654 |
| ▪ Laframboise, Louis | A10684 |
| ▪ Schultz, Anne | A1880 |

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I certify that this report was prepared reflecting the asbestos policy of the VA, the best professional practice of asbestos inspections and all applicable regulations. Further that this report reflects accurately the location, current condition and quantity of asbestos-containing materials (ACM) and the location and quantity of asbestos contaminated elements (ACE) in all of the areas that could be accessed without destructive methods being used. Furthermore I certify that the assessment of ACM and ACE in areas that could not be accessed without structural damage have been noted based on previous reassessments and available information and data.



Prepared by: Anne Schultz - Asbestos inspector A1880

I certify that I have reviewed the survey and assessment report for the VA Ann Arbor Medical Center



Michael R. Tillotson - CIH, CHMM

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HA	MATL	HA DESCRIPTION	COMMENT
1	MM	1' x 1' Floor tile; Cream with brown streaks (light and dark)	Positive
2	MM	7" Black vinyl cove base	Negative
3	MM	Mastic under HA # 1	Positive
4	MM	Mastic under HA # 2	Negative
5	MM	2' x 2' Ceiling tile; White with random pattern & smooth finish	Negative
6	TSI	Mudded pipe fittings on steam lines; <2" diameter pipes	Positive
7	MM	1' x 1' Floor tile; Tan with brown and white streaks	Positive
8	MM	Mastic under HA # 7	Negative
9	TSI	Insulation on domestic pipe straight runs; <2" diameter pipes	Positive - Only SB & Bldg. 3 Basement
10	SM	Plaster on expanded wire mesh ceiling	Negative
11	MM	6" Brown vinyl cove base	Negative
12	MM	Mastic under HA # 11	Negative
13	MM	9" x 9" Floor tile; Olive with brown and white streaks	Positive
14	MM	4" Black vinyl cove base	Negative
15	MM	Mastic under HA # 14	Negative
16	MM	Mastic under HA # 13	Positive
17	TSI	Insulation on straight run; <2" dia. Pipes	Negative
18	TSI	Mudded pipe fittings on domestic water lines; <2" dia. Pipes	Positive
19	MM	1' x 1' Ceiling tile; Random pattern, smooth finish; glued on	Negative
20	MM	1' x 1' Floor tile; White with grey flecks	Positive - Only Bldg. 22
21	MM	7" Brown vinyl cove base	Negative
22	MM	Mastic under HA # 21	Negative
23	MM	Mastic under HA # 20	Positive - Only Bldg. 22
24	MM	2' x 2' Ceiling tile, white with random dotted pattern, smooth finish	Negative
25	TSI	Insulation on steam pipes; >2", <6" diameter pipes	Positive
26	TSI	Mudded pipe fittings on steam lines; >2", <6" diameter pipes	Positive
27	MM	Linoleum, Brown terrazzo pattern	Positive - No Longer Found in Facility
28	MM	Mastic under HA # 27	Negative
29	MM	4" Tan vinyl cove base	Negative
30	MM	Mastic under HA # 29	Negative
31	MM	7" Grey vinyl cove base	Negative
32	MM	Mastic under HA # 31	Negative
33	MM	2' x 2' Ceiling tile; White with rough finish; lay-in	Negative
34	MM	1' x 1' Floor tile; Tan with blue, brown and white flecks	Negative
35	MM	Mastic under HA # 34	Negative
36	MM	6" Tan vinyl cove base	Negative
37	MM	Mastic under HA # 36	Negative
38	MM	7" Blue vinyl cove base	Negative

VA Medical Center - Ann Arbor, MI - HA List

HA	MATL	HA DESCRIPTION	COMMENT
39	MM	Mastic under HA # 38	Negative
40	TSI	CWS fittings >2" - <6" diameter	Positive - No Longer Found in Facility
41	TSI	HWS fittings <2" diameter	Negative
42	TSI	HWR fittings <2" diameter	Positive - No Longer Found in Facility
43	TSI	Drip return fittings <2" diameter	Positive - No Longer Found in Facility
44	TSI	LPS straight runs on pipes <2" diameter	Positive
45	TSI	LPS fittings <2" diameter	Positive - No Longer Found in Facility
46	TSI	LPS fittings, >2" - <6" diameter	Positive - No Longer Found in Facility
47	TSI	MPS fittings <2" diameter	Positive - No Longer Found in Facility
48	TSI	MPS vessel mud insulation	Negative
49	TSI	HWR vessel mud insulation	Negative
50	TSI	Condensate fittings <2" diameter	Positive - No Longer Found in Facility
51	TSI	Make-up water fittings <2" diameter	Positive - No Longer Found in Facility
52	TSI	CWS vessel mud insulation	Negative
53	TSI	Make-up water straight runs <2" diameter	Positive - No Longer Found in Facility
54	MM	Blue check wall covering	Negative
55	MM	Tan cloth-pattern wall covering	Negative
56	SM	White finish plaster	Negative
57	MM	Linoleum, Dark brown terrazzo pattern	Positive - No Longer Found in Facility
58	MM	Drywall with mud and tape	Negative
59	MM	Light blue wall covering	Negative
60	MM	Vibration Decoupler on HVAC duct (Exp. joint grey woven material)	Positive
61	MM	Tan cloth wall cover with wheat head graphics	Negative
62	MM	Beige cloth wall covering with horizontal grain	Negative
63	MM	2' x 4' Ceiling tile; White with eight raised panels	Negative
64	MM	1' x 1' Floor tile; Tan with white and grey specks	Negative
65	MM	2' x 2' Wall panels with regular-spaced holes	Positive
66	MM	1' x 2' Ceiling tile; White fibrous (old, above ceiling in sacristy)	Negative
67	MM	4" Burgundy vinyl cove base	Negative
68	MM	Mastic under HA # 67	Negative
69	TSI	Mudded pipe fittings on millboard-insulated lines <2" diameter	Positive
70	TSI	Straight run millboard insulation <2" diameter pipes	Positive

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HA	MATL	HA DESCRIPTION	COMMENT
71	TSI	Mag insulation on <2" diameter pipes	Positive
72	MM	Mauve burlap-pattern wall covering	Negative
73	MM	Tan with blue specks wallpaper	Negative
74	TSI	Air cell pipe insulation straight runs <2" diameter	Positive - No Longer Found in Facility
75	TSI	Black cork pipe insulation with tan seams	Negative
76	MM	2' x 4' Ceiling tile, White lay-in with random dotted pattern	Negative
77	MM	9" x 9" Floor tile; Beige with white streaks	Negative
78	MM	Mastic under HA # 77	Positive - No Longer Found in Facility
79	MM	1' x 1' Floor tile; Cream with caramel swirl pattern	Negative
80	MM	Mastic under HA # 79	Positive - No Longer Found in Facility
81	MM	1' x 1' Floor tile; Cream with caramel streaks pattern	Negative
82	MM	Mastic under HA # 81	Positive
83	MM	1' x 1' Floor tile; Aqua with red, black and white dots	Negative
84	MM	Mastic under HA # 83	Positive - No Longer Found in Facility
85	MM	1' x 1' Floor Tile; Beige with blue and red	Negative
86	MM	Mastic under HA # 85	Positive
87	MM	Zigzag pattern wall cover; tan, blue and white	Negative
88	MM	Linoleum, Grey terrazzo pattern	Negative
89	MM	Mastic under HA # 88	Negative
90	MM	Cream vinyl cloth-pattern wall cover	Negative
91	MM	Criss-cross pattern mauve-colored wall covering	Negative
92	MM	Dark blue cloth pattern wall covering	Negative
93	MM	2' x 2' Ceiling panel; Drywall with vinyl finish	Negative
94	MM	Mauve vertical-textured stripe wall covering	Negative
95	MM	4" Cream vinyl cove base	Negative
96	MM	Mastic under HA # 95	Negative
97	MM	Blue with white specks wall covering	Negative
98	MM	Pink with tiny (1/8") squares wall covering	Negative
99	MM	2 1/2' x 5' Ceiling tile; White with pin holes	Negative
100	TSI	Mag-insulated pipes and fittings >2" - <6" diameter	Positive
101	MM	9" x 9" Floor Tile; Darker	Negative
102	MM	Blue herringbone pattern wall cover	Negative
103	MM	Mastic under HA # 101	Negative
104	MM	Beige wall covering with mild white texture	Negative
105	MM	Cream wall covering with repeating 6-groove pattern	Negative
106	MM	Pale yellow wall covering with mustard swirls	Negative
107	MM	1' x 1' Floor tile; Tan with brown and grey flecks	Negative

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HA	MATL	HA DESCRIPTION	COMMENT
108	MM	Mastic under HA # 107	Positive - Not in Bldg. T3
109	MM	Blue vertical-texture stripe wall covering	Negative
110	SM	White rolled-on ceiling texture	Negative
111	MM	Beige ladder-pattern wall covering	Negative
112	MM	1' x 1' Ceiling tile; White painted worm-hole	Negative
113	MM	Orange-peel texture wall covering - assorted pastel colors	Negative
114	MM	Dark colors orange-peel-texture wall covering	Negative
115	MM	Blue ladder-pattern wall covering	Negative
116	TSI	Felt insulation on domestic straights >2 - <6"	Negative
117	TSI	Mudded pipe fittings on felt-insulation lines >2 - <6"	Positive - No Longer Found in Facility
118	MM	Mauve cloth-pattern wall covering	Negative
119	MM	9' x 9' Floor tile; Red with cream streaks	Positive
120	MM	Mastic under HA # 119	Positive
121	MM	Blue vinyl with mild texture wall covering	Negative
122	TSI	HPS Mudded fittings <2"	Positive - No Longer Found in Facility
123	TSI	Chilled water mudded fittings < 2"	Positive - No Longer Found in Facility
124	MM	White vinyl wall covering	Negative
125	MM	1' x 1" Floor tile; Beige with white streaks	Negative
126	MM	Mastic under HA # 125	Negative
127	MM	Cork ceiling 3" deep	Negative
128	MM	Linoleum, White with blue, brown and tan specks	Negative
129	MM	Mastic under HA # 128	Negative
130	SM	Spray-on insulation	Positive - 8th Floor Only
131	MM	Linoleum, Blue with grey and dark specks	Negative
132	MM	Mastic under HA # 131	Negative
133	MM	2' x 4' Ceiling tile; Large pattern white	Negative
134	TSI	Drain fittings >2" - <6"	Positive
135	MM	Linoleum, tan with grey and dark specks	Negative
136	MM	Mastic under HA # 135	Negative
137	MM	Fibrous drywall	Negative
138	MM	Plaster fill material around conduit penetrations through Floor	Negative
139	TSI	Drain line >2" - <6"	Positive
140	MM	Off-white with 1/4" squares random peach and grey dots wall cover	Negative
141	MM	Peach border wall covering	Negative
142	MM	Pale yellow cloth-like wall covering	Negative
143	MM	Green ladder-pattern wall covering	Negative

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HA	MATL	HA DESCRIPTION	COMMENT
144	TSI	New mud on newly-insulated fiberglass lines	Negative
145	TSI	Cork on brine line <2"	Negative
146	MM	Tan herringbone (3" wide pattern) wall covering	Negative
147	MM	1' x 1' Floor tile; Light grey with blue, aqua and dark grey dots	Negative
148	MM	Mastic under HA # 147	Negative
149	MM	9" x 9" Floor tile; Tan with green speckles	Positive
150	MM	Mastic under HA # 149	Negative
151	MM	9" x 9" Floor tile; white with grey streaks	Positive
152	MM	Mastic under HA # 151	Positive
153	TSI	Debris left from previous activities	Positive
154	MM	9" x 9" Floor tile; Black with green dots Floor tile	Negative
155	MM	Mastic under HA # 154	Negative
156	MM	Linoleum, Beige terrazzo pattern	Negative
157	MM	Mastic under HA # 156	Negative
158	MM	1' x 1' Floor tile; Pink with brown, maroon and white specks	Negative
159	MM	Mastic under HA # 158	Negative
160	MM	1' x 1' Floor Tile with white specks	Negative
161	MM	Mastic under HA # 160	Negative
162	TSI	Brine fittings >2" - <6"	Negative
163	TSI	CWS >2" - <6"	Negative
164	TSI	CWS fittings >2" - <6"	Negative
165	TSI	Steam fittings >6"	Negative
166	TSI	Steam pipe >6"	Negative
167	TSI	Cold water fitting with black tar >6"	Negative
168	MM	Construction adhesive lt. brown color	Negative
169	MM	Gasket material from wall heaters in kitchen	Negative
170	MM	Unknown base tiles under cafe eating area Floor	Negative
171	TSI	Insulation on domestic water tank	Negative
172	TSI	Insulation on steam tank	Negative
173	MM	Beige with brown and aqua diamonds wall covering	Negative
174	MM	Beige with repeating pattern of lines and crosses - brown and aqua	Negative
175	MM	Beige with aqua lines wall covering	Negative
176	MM	Tan vertical-textured stripe wall covering	Negative
177	TSI	Chrysotile duct and insulation	Positive
178	MM	Mauve and aqua spattered pattern wall covering	Negative
179	MM	1' x 1' Floor tile; White with grey and brown flecks	Negative
180	MM	Mastic under HA # 179	Negative
181	MM	1' x 1' Floor tile; Olive with brown and white flecks	Positive
182	MM	Mastic under HA # 181	Positive
183	MM	Green with white flecks (textured) wall covering	Negative
184	MM	1' x 1' Floor tile; Olive with green and white streaks	Positive

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HA	MATL	HA DESCRIPTION	COMMENT
185	MM	Mastic under HA # 184	Positive
186	MM	Off white with 1/4" squares and random mauve and purple dots	Negative
187	MM	9" x 9" Floor tile; Olive with green and white streaks	Negative
188	MM	Mastic under HA # 187	Negative
189	TSI	Vacuum mud fitting <2"	Positive - No Longer Found in Facility
190	MM	9" x 9" Floor tile; Blue-green with cream and navy streaks	Positive - No Longer Found in Facility
191	MM	Mastic under HA # 190	Negative
192	MM	Light brown with diamonds & squares (textured) wall covering	Negative
193	TSI	Drain pipe insulation >2" - <6"	Negative
194	TSI	Tar wrap on <2" domestic	Negative
195	TSI	Brown foam on >2" - <6"	Negative
196	MM	Brown fibrous pressboard	Negative
197	MM	Tan weave-pattern wall covering	Negative
198	TSI	Mud patch on fiberglass duct insulation	Negative
199	TSI	HW mud fitting <2"	Negative
200	TSI	CW Mud fitting <2"	Negative
201	TSI	Chilled or heating water supply Mudded pipe fittings <2"	Negative
202	TSI	Chilled or heating water return <2"	Negative
203	TSI	Chilled water return mud fitting >2" - <6"	Negative
204	TSI	CW straight <2"	Positive
205	TSI	CW straight >2" - <6"	Positive - No Longer Found in Facility
206	TSI	HW straight <2"	Positive
207	TSI	HW straight >2" - <6"	Negative
208	SM	Fibrous sprayed-on in Bldg. 28	Negative
209	SM	Cellulose sprayed-on in C200, Bldg. 28	Negative
210	MM	1' x 1' Floor tile; Cream with grey and brown streaks	Negative
211	MM	Mastic under HA # 210	Negative
212	MM	1' x 1' Floor tile; Grey with white and brown streaks	Negative
213	MM	Mastic under HA # 212	Negative
214	TSI	Drip return fitting >2" - <6"	Positive - No Longer Found in Facility
215	MM	1" wide fibrous duct tape	Positive
216	MM	Linoleum, White with blue, red, purple and green specks	Negative
217	MM	Mastic under HA # 216	Negative
218	MM	Linoleum, White with tan streaks	Negative
219	MM	Mastic under HA # 218	Negative
220	MM	Linoleum, White with 5" grey-outline squares	Negative
221	MM	Mastic under HA # 220	Negative
222	MM	1' x 1' Floor tile; Green with cream and dark green streaks	Negative

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HA	MATL	HA DESCRIPTION	COMMENT
223	MM	Mastic under HA # 222	Negative
224	MM	Linoleum, Beige with brown streaks	Positive
225	MM	Mastic under HA # 224	Negative
226	MM	1' x 1' Floor tile; Light grey with aqua and dark grey streaks	Positive
227	MM	Mastic under HA # 226	Negative
228	TSI	Roof drain straight insulation. >2", ≤6" black tar-like appearance	Negative
232	TSI	Steam mud fitting >2", ≤6", Bldg. 22 (Originally listed as 228a)	Negative
229	TSI	Domestic mud fitting ≤2", Bldg. 22	Negative
230	TSI	Condensate tank mud, Bldg. 22	Negative
231	MM	Mastic under HA # 64 (Originally listed as 64a)	Positive
233	MM	9" x 9" Floor tile; Green with white streaks	Positive - No Longer Found in Facility
234	MM	Mastic under HA # 233	Negative
235	MM	9" x 9" Floor tile; Red with cream and black streaks	Positive - No Longer Found in Facility
236	MM	Mastic under HA # 235	Negative
237	MM	Transite panel/board material	Positive
238	MM	Brown fibrous board material	Positive - Located behind transite panel on flush mounted wall registers
239	MM	Black Lab Tops with groove under lip	Positive
240	MM	Debris from previous renovation	Negative
241	MM	Black sink undercoating	Positive
242	MM	White sink undercoating	Positive
243	MM	Grey sink undercoating	Negative
244	MM	9" x 9" Floor tile; Light green with dark green streaks	Positive - No Longer Found in Facility
245	MM	Mastic under HA # 244	Negative
246	MM	Pink sink undercoating	Positive
247	MM	Linoleum, Tan with grey and black streaks	Negative
248	MM	Mastic under HA # 247	Negative
249	MM	1' x 1' Floor tile; Reddish brown with black and red streaks	Negative
250	MM	Mastic under HA # 249	Negative
251	MM	1' x 1" Floor tile; Grey with dark and light grey streaks	Negative
252	MM	Mastic under HA # 251	Negative
253	MM	Black Tar sink undercoating	Negative
254	MM	Elevator brake pads	Positive
255	SM	Fire Brick	Positive
276	SM	Wall plaster	Positive - Bldg. 3 Only
283	MM	Glue pods on 1' x 1' ceiling tile	Positive
285	TSI	Straight run millboard insulation 2" - 6" diameter pipes	Positive

VA Medical Center - Ann Arbor, MI - HA List

HA	MATL	HA DESCRIPTION	COMMENT
286	TSI	Mudded pipe fittings on millboard - insulated lines 2" - 6" diameter pipes	Positive
290	TSI	Debris underneath Mudded Fittings	Negative
291	MM	Caulk, Brittle Tan	Negative
292	MM	Expansion Cloth, Woven Tight Weave	Negative
293	MM	Gasket, Felt Material	Negative
294	SM	Board, Gray Powdery	Negative
295	MM	Tar Tape Wrap on Pipe	Negative
296	MM	Duct Putty: Silver	Negative
297	MM	Duct Putty: Light Brown	Positive - Bldg. 22 Penthouse
298	MM	Spray-on insulation: Stairwell	Positive - Bldg. 22 Penthouse
299	MM	Expansion Cloth, Woven Heavy Weave	Positive - Bldg. 22 Penthouse
300	MM	Expansion Joint, Black Rubberized	Negative
301	MM	Expansion Joint, Silver Rubberized	Negative
302	TSI	Duct Insulation, Canvas & Mud over Fiberglass	Negative
303	TSI	CW Mud Fitting on Fiberglass Straight <2"	Negative
304	TSI	Abandoned Line Mud Fitting on Fiberglass Straight <2"	Negative
305	TSI	Steam Line, Straight Run Preformed Block >2"<4"	Positive - Bldg. 22 Penthouse
306	TSI	Steam Line Mud Fittings on Straight Run Preformed Block >2"<4"	Positive - Bldg. 22 Penthouse
307	TSI	Steam Mud Fitting on Fiberglass Straight <2"	Negative
308	TSI	Condensate Mud Fitting on Fiberglass Straight <2"	Negative
309	TSI	Condensate Tank Insulation: Mud over Fiberglass	Negative
310	TSI	Heat Exchanger Insulation: Mud over Fiberglass	Negative
311	TSI	Hot Water Tank Insulation: Mud over Fiberglass	Positive - Bldg. 22 Penthouse
312	TSI	Hot Water Lines Mud Fitting on Fiberglass Straight <2"	Negative

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SAMPLE NO	NO	HA	MATL	HA DESCRIPTION	SAMPLE LOCATION	RESULTS	DUPLICATE
01-06-134-189	189	134	TSI	Drain Fittings >2" - <6"	Room A618, 9' from South Wall, 2' from East Wall, 8' from Floor	20% Chrysotile	
01-06-134-190	190	134	TSI	Drain Fittings >2" - <6"	Room A615A, 5' from North Wall, 2' from East Wall, 8' from Floor	50% Chrysotile	
01-06-139-191	191	139	TSI	Drain Line >2" - <6"	Room A615A, 2' from North Wall, 2' from East Wall, 8' from Floor	5% Chrysotile	
01-06-119-192	192	119	MM	9" x 9" Floor Tile, Red w/Cream Streaks	Room A617A, Northeast Corner of Room	Tile 20% Chrysotile, Mastic 25% Chrysotile	
01-06-175-193	193	175	MM	Beige w/Aqua Lines Wall Covering	Room C602C, Southwest Corner of Door Jamb Just above Cove	ND	
01-06-175-194	194	75	TSI	Black Cork Pipe Insulation w/Tan Seams	Room C602, 1' from South Wall, 21' East of Double Door	ND	ND
01-06-174-195	195	174	MM	Beige w/Repeating Pattern of Lines & Crosses - Brown & Aqua	Room A657, South Wall behind Outlet Cover, 3' from Floor	ND	
01-06-175-196	196	175	MM	Beige w/Aqua Lines Wall Covering	Room A605, by South Door Jamb, above Cove	ND	
01-06-173-197	197	173	MM	Beige w/Brown & Aqua Diamonds Wall Covering	Room A668, Southwest Corner under Base Cove	ND	
01-06-183-198	198	183	MM	Green w/White Flecks (textured) Wall Covering	Room B634, East Wall under Window Sill Ledge	ND	
01-06-186-199	199	186	MM	Off White w/1/4" Squares & Random Mauve & Purple Dots	Room C607, West Wall under Cove, North Side of Door Jamb, Room B601 in C607	ND	
01-06-181-200	200	181	MM	1' x 1' Floor Tile, Olive w/Brown & White Flecks	Room B620, North Floor by Job, 1/1/2' West of Door	Tile ND, Mastic 5%	
01-06-181-201	201	181	MM	1' x 1' Floor Tile, Olive w/Brown & White Flecks	Room B627A, Along East Wall by Cove, Southeast Corner of Room	Tile 5% Chrysotile, Mastic ND	
01-06-06-202	202	6	TSI	Mudded Pipe Fittings on Steam Lines, <2" Diameter Pipes	Room A636, 3' from North Wall, 2' from East Wall, 9' from Floor	60% Chrysotile	40% Chrysotile
01-08-192-203	203	192	MM	Light Brown w/Diamonds & Squares (textured) Wall Covering	Room A801, East Wall Under Cove Directly in Line w/Outlet, 4' from North Corner	ND	
01-08-191-204	204	191	MM	Mastic Under HA # 190	Room B803A, 3-1/2' from North Wall along West Cove	ND	
01-08-190-205	205	190	MM	9" x 9" Floor Tile, Blue-Green w/Cream & Navy Streaks	See #204 N803A	10% Chrysotile	
01-08-130-206	206	130	SM	Spray-On Insulation	Room B819A, Along Wall between B819 & B819A, 10' from South Wall, 1' East	10% Chrysotile	

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SAMPLE NO	NO	HA	MATL	HA DESCRIPTION	SAMPLE LOCATION	RESULTS	DUPLICATE
01-08-193-207	207	193	TSI	Drain Pipe Insulation >2" - <6"	Room C807, Outside of Room B818, 3' from East Wall	ND	
01-09-195-208	208	195	TSI	Brown Foam on >2" - <6"	Room B904, 2' from South Wall, 3' from East Wall, 5' from Floor	ND	
01-10-41-209	209	41	TSI	HWS Fittings <2" Diameter	Room AHU 10, 3' from West Wall, 12' South of North Wall, 1' from Floor	ND	
01-10-42-210	210	42	TSI	HWR Fittings <2" Diameter	Room AHU 10, 3' from West Wall, 12' South of North Wall, 1' from Floor	2% Chrysotile	
01-10-43-211	211	43	TSI	Drip Return Fittings <2" Diameter	Room AHU10, 1' from West Wall, 30' North of South Wall, 1-1/2' from Floor	40% Chrysotile	
01-10-60-212	212	60	MM	Vibration Damper Connection on HVAC Duct (expansion joint grey woven material)	15' North of Door, 9' from West Wall, 1' from Floor	80% Chrysotile	
01-10-205-213	213	205	TSI	CW Straight >2" - <6"	1' South of North Wall, 14' East of West Wall, 4' from Floor under Asbestos Tag 10	ND	
01-10-45-214	214	45	TSI	LPS Fittings <2" Diameter	9' South of North Wall, 16' West of East Wall, 4' from Floor 10	ND	
01-10-199-215	215	199	TSI	HW Mud Fitting <2"	8' South of North Wall, 17' West of East Wall, 12' from Floor	ND	
01-10-199-216	216	199	TSI	HW Mud Fitting <2"	9' South of North Wall, 17' West of East Wall, 1-1/2' from Floor 10	ND	
01-10-204-217	217	204	TSI	CW Straight <2"	18' South of North Wall, 18' West of East Wall, 3' from Floor 10	ND	ND
01-10-206-218	218	206	TSI	HW Straight <2"	18' South of North Wall, 17' West of East Wall, 3' from Floor 10	ND	
01-10-200-219	219	200	TSI	CW Mud Fitting <2"	10' South of North Wall, 17' West of East Wall, 10' from Floor 10	ND	
01-10-200-220	220	200	TSI	CW Mud Fitting <2"	12' South of North Wall, 17' West of East Wall, 10' from Floor 10	ND	
01-10-201-221	221	201	TSI	Chilled or Heating Water Supply Mudded Pipe Fittings <2"	18' South of North Wall, 18' West of East Wall, 4' from Floor 10	ND	
01-10-201-222	222	201	TSI	Chilled or Heating Water Supply Mudded Pipe Fittings <2"	9' South of North Wall, 16' East of West Wall, 5' from Floor	ND	
01-10-202-223	223	202	TSI	Chilled or Heating Water Return <2"	9' South of North Wall, 7' East of West Wall, 3' from Floor	ND	ND
01-10-40-224	224	40	TSI	CWS Fittings >2" - <6" Diameter	32' North of South Wall, 15' East of West Wall, 5' from Floor Tag #69-93-10-9	ND	

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SAMPLE NO	NO	HA	MATL	HA DESCRIPTION	SAMPLE LOCATION	RESULTS	DUPLICATE
01-10-203-225	225	203	TSI	Chilled Water Return Mud Fitting >2" - <6"	29' North of South Wall, 15' East of West Wall, 3' from Floor 10	ND	
01-10-199-226	226	199	TSI	HW Mud Fitting <2"	11' East of West Wall, 36' South of North Wall, 11' from Floor 10	ND	
01-10-199-227	227	199	TSI	HW Mud Fitting <2"	12' West of East Wall, 36' South of North Wall, 11' from Floor 10	ND	
01-10-200-228	228	200	TSI	CW Mud Fitting <2"	1' South of North Wall, 16' East of West Wall	ND	
01-10-206-229	229	206	TSI	HW Straight <2"	1' West of East Wall, 18' South of North Wall, 3' from Floor	2% Chrysotile	
01-10-204-230	230	204	TSI	CW Straight <2"	1' West of East Wall, 18' South of North Wall, 3' from Floor	2% Chrysotile, 2.5% Chrysotile Black Layer	ND By TEM, Missing Black Layer
01-10-206-231	231	206	TSI	HW Straight <2"	12' North of South Wall, 8' West of North Wall, 4' from Floor 10	2% Chrysotile	
01-10-204-232	232	204	TSI	CW Straight <2"	12' North of South Wall, 8' West of North Wall, 4' from Floor 10	ND	
01-10-201-233	233	201	TSI	Chilled or Heating Water Supply Mudded Pipe Fittings <2"	14' West from East Wall, 12' South of North Wall, 12' from Floor 10	ND	
01-10-202-234	234	202	TSI	Chilled or Heating Water Return <2"	2' South of North Wall, 6' West of East Wall, 11' from Floor 10	ND	
01-10-205-235	235	205	TSI	CW Straight >2" - <6"	1' North of South Wall, 24' West of East Wall, 3' from Floor 10	20% Chrysotile	
01-10-205-236	236	205	TSI	CW Straight >2" - <6"	25' North of South Wall, 24' West of East Wall, 3' from Floor 10	2% Chrysotile	
01-10-206-237	237	206	TSI	HW Straight <2"	25' North of South Wall, 24' West of East Wall, 4' from Floor 10	ND	
28-02-209-238	238	209	SM	Cellulose Sprayed-On in C200, Bldg. 28	Room C200, 5' North of Door, 6' West of C200C, 8' from Floor	ND	
28-02-208-239	239	208	SM	Fibrous Sprayed-On in Bldg. 28	Room C230, Lying on 2nd Beam by Catwalk (mezzanine)	ND	
28-02-210-240	240	210	MM	1' x 1' Floor Tile, Cream w/Grey & Brown Streaks	Room C230, Doorway of Room, West Corner	ND	
28-02-212-241	241	212	MM	1' x 1' Floor Tile, Grey w/White & Brown Streaks	Room C207, Doorway of Room, West Corner	ND	
28-02-192-242	242	192	MM	Light Brown w/Diamonds & Squares (textured) Wall Covering	Room 210, Behind North Door between Top & Middle Hinge along Jamb	ND	

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SAMPLE NO	NO	HA	MATL	HA DESCRIPTION	SAMPLE LOCATION	RESULTS	DUPLICATE
28-02-113-243	243	113	MM	Orange-Peel Texture Wall Covering - Assorted Pastel Colors	Room C218, West Wall South Corner under Base Cove	ND	
28-02-208-244	244	208	SM	Fibrous Sprayed-On in Bldg. 28	Room C212, Along West Wall, 3' from South Corner, 12' from Floor	ND	ND
28-02-113-245	245	113	MM	Orange-Peel Texture Wall Covering - Assorted Pastel Colors	Room D262, Northeast Corner by Door under Cove	ND	
28-02-113-246	246	113	MM	Orange-Peel Texture Wall Covering - Assorted Pastel Colors	Room D260, on West Wall, Damaged Spot Mid PT	ND	
28-02-208-247	247	208	SM	Fibrous Sprayed-On in Bldg. 28	Room C240, Along West Wall, 16' North of Southwest Corner, 12' from Floor	ND	
28-02-62-248	248	62	MM	Beige Cloth Wall Covering w/Horizontal Grain	Room D250, Southwest Corner, 4' from Floor	ND	
28-02-62-249	249	62	MM	Beige Cloth Wall Covering w/Horizontal Grain	Room D216, Northwest Corner of Bathroom Door	ND	
28-02-62-250	250	62	MM	Beige Cloth Wall Covering w/Horizontal Grain	Room D219, Under Window Sill along Heater	ND	
28-01-210-251	251	210	MM	1' x 1' Floor Tile, Cream w/Grey & Brown Streaks	Room D105, Along South Wall of Bathroom, 3' East of Door	ND	
28-01-208-252	252	208	SM	Fibrous Sprayed-On in Bldg. 28	Room D107, 2' from North Wall, 18' West of East End	ND	
28-03-222-253	253	222	MM	1' x 1' Floor Tile, Green w/Cream & Dark Green Streaks	Room 3C104, Door Jamb of C308, East Corner	ND	
28-03-208-254	254	208	SM	Fibrous Sprayed-On in Bldg. 28	Room C307, Along East Wall, 4' South of Door	ND	
28-03-224-255	255	224	MM	Linoleum, Beige w/Brown Streaks	South Corner of Door Stair #1	ND	12% Chrysotile
28-01-212-256	256	212	MM	1' x 1' Floor Tile, Grey w/White & Brown Streaks	Room D115, Corridor by Room, Door Jamb	ND	
28-01-211-257	257	211	MM	Mastic under HA # 210	Same as 28-01-210-251	ND	
01-01-122-258	258	122	TSI	HPS Mudded Fittings <2"	Room A117, 1' from South Wall, 15' from East Wall, 5' from Floor	55% Chrysotile	
01-01-88-259	259	88	MM	Linoleum, Grey Terrazzo Pattern	Room A160, Southwest Corner of Room by Metal Strip	ND	
01-01-89-260	260	89	MM	Mastic under HA # 88	Same as 01-01-88-259 A160	ND	
28-02-213-261	261	213	MM	Mastic under HA # 212	Room C204, Doorway of West Door of Mechanical Room	Insufficient	
28-02-225-262	262	225	MM	Mastic under HA # 224	Stairway 1, Second Level, Southwest Corner under Linoleum	ND	

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SAMPLE NO	NO	HA	MATL	HA DESCRIPTION	SAMPLE LOCATION	RESULTS	DUPLICATE
01-03-161-263	263	161	MM	Mastic under HA # 160	Room C314, Along North Wall under Plate for Register where Booths Start	ND	
01-08-191-264	264	191	MM	Mastic under HA # 190	Room B803A, Storage Room West Wall, 40' South of North Wall	ND	
01-01-86-266	266	86	MM	Mastic under HA # 85	16' East, 19' South of Northwest Corner in Admitting Lobby	10% Chrysotile	
01-01-84-267	267	84	MM	Mastic under HA # 83	16' East, 19' South of Northwest Corner in Admitting Lobby	20% Chrysotile	
01-04-155-268	268	155	MM	Mastic under HA # 154	Room B426, by Sink along North Wall	ND	
01-01-83-269	269	83	MM	1' x 1' Floor Tile, Aqua w/Red, Black & White Dots	Same as # 01-01-84-267	Tile & Mastic ND	
01-03-111-300	300	111	MM	Beige Ladder-Pattern Wall Covering	Room A333, Southeast Corner above Door	ND	
01-03-113-301	301	113	MM	Orange-Peel Texture Wall Covering - Assorted Pastel Colors	Room A331A, Next to Door Casing Outside Entry	ND	
01-03-114-302	302	114	MM	Dark Colors Orange-Peel-Texture Wall Covering	Room A331, 8' from North Wall, 16' from East Wall, 4' from Floor, (corner where peeling)	ND	
01-03-10-303	303	10	SM	Plaster on Expanded Wire Mesh Ceiling	Room A304, Northeast Corner above Door @ Existing Hole in Plaster	ND	
01-03-115-304	304	115	MM	Blue Ladder-Pattern Wall Covering	Room A325, North Edge of East Wall, 3' from Floor	ND	
01-03-74-305	305	74	TSI	Air Cell Pipe Insulation Straight Runs <2" Diameter	Room A328, Above Ceiling @ East Access Hatch above Ceiling	40% Chrysotile	
01-03-116-306	306	116	TSI	Felt Insulation on Domestic Straights >2 - <6"	Room A328, Above Ceiling @ Central Access Hatch	ND	ND
01-03-118-307	307	118	MM	Mauve Cloth-Pattern Wall Covering	Room A357A, East Wall under Radiator	ND	
01-03-74-307	307	74	TSI	Air Cell Pipe Insulation Straight Runs <2" Diameter	Room A338A, Above Ceiling Near Access Panel from East Pipe Running North/South	45% Chrysotile	
01-03-20-308	308	20	MM	1' x 1' Floor Tile, White w/Grey Flecks	Room A357A, Behind Door in Northwest Corner	ND	
01-03-74-308	308	74	TSI	Air Cell Pipe Insulation Straight Runs <2" Diameter	Room A338A, from West Pipe Running North/South	80% Chrysotile	85% Chrysotile
01-03-146-309	309	146	MM	Tan Herringbone (3" wide pattern) Wall Covering	Room B300, in Northwest Corner, 1.5' from Floor	ND	
01-03-23-309	309	23	MM	Mastic under HA # 20	Mastic under Sample # 308	ND	

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VA Medical Center - Ann Arbor, MI - Sample Locator

SAMPLE NO	NO	HA	MATL	HA DESCRIPTION	SAMPLE LOCATION	RESULTS	DUPLICATE
01-03-133-310	310	133	MM	2' x 4' Ceiling Tile, Large Pattern White	Room A357, Above Ceiling, Northeast Corner of Room	ND	
01-03-149-310	310	149	MM	9" x 9" Floor Tile, Tan w/Green Speckles	Room A351, 6.5' Southeast from Central Column in Room	Tile 5% Chrysotile, Mastic ND	
01-03-26-311	311	26	TSI	Mudded Pipe Fittings on Steam Lines; >2", <6" Diameter Pipes	Room A347, Southwest Corner above Water Damaged Ceiling Tile	2% Chrysotile	
01-03-69-311	311	69	TSI	Mudded Pipe Fittings on Millboard-Insulated Lines <2" Diameter	Room A357, Above Ceiling, 14' from South Wall, 11' from East Wall	80% Chrysotile	90% Chrysotile
01-03-101-312	312	101	MM	9" x 9" Floor Tile, Darker	Room 357, North End, Floor Next to Door (west side of door)	ND	
01-03-153-312	312	153	TSI	Debris Left from Previous Activities	Room B309, 4th Ceiling Tile from North & 4th from East Wall	40% Chrysotile	30% Chrysotile
01-03-103-313	313	103	MM	Mastic under HA # 101	Mastic under Sample # 312	ND	
01-03-151-313	313	151	MM	9" x 9" Floor Tile, White w/Grey Streaks	Room B309D, West Edge of Floor in South Corner of Room B309D, CO9D (southwest corner by door)	Tile 5% Chrysotile, Mastic ND	
01-03-151-314	314	151	MM	9" x 9" Floor Tile, White w/Grey Streaks	Room B309C, Northeast Corner Near Radiator	Tile ND, Mastic 10% Chrysotile	
01-03-77-314	314	77	MM	9" x 9" Floor Tile, Beige w/White Streaks	Room A357A, Right Side of Door Jamb, Sample Actually in A357	ND	
01-03-152-315	315	152	MM	Mastic under HA # 151	Room B309, North End @ Door	ND	
01-03-78-315	315	78	MM	Mastic under HA # 77	Beneath Sample# 314	ND	
01-03-01-316	316	1	MM	1' x 1' Floor Tile, Cream w/Brown Streaks (light and dark)	Room A318, Southwest Corner	ND	
01-03-158-316	316	158	MM	1' x 1' Floor Tile, Pink w/Brown, Maroon & White Specks	Room B314, East Wall, 17' from North Wall, Edge of Floor	Tile & Mastic ND	
01-03-03-317	317	3	MM	Mastic under HA # 1	Beneath Sample #316	ND	
01-03-160-317	317	160	MM	1' x 1' Floor Tile w/White Specks	Room B314, East Wall, 17' from North Wall, Edge of Floor	Tile & Mastic ND	
01-03-170-318	318	170	MM	Unknown Base Tiles under Cafe Eating Area Floor	Room B314, East Wall, 17' from North Wall, Edge of Floor	Tile & Mastic ND	ND
01-03-69-318	318	69	TSI	Air Cell Pipe Insulation Straight Runs <2" Diameter	Room A309, Northwest Corner Over Door	60% Chrysotile	
01-03-121-319	319	121	MM	Blue Vinyl w/Mild Texture Wall Covering	Room B314, East Wall, 17' from North Wall about 40' from Floor	ND	
01-03-70-319	319	70	TSI	Straight Run Millboard Insulation <2" Diameter Pipes	Near Sample #318	ND	

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SAMPLE NO	NO	HA	MATL	HA DESCRIPTION	SAMPLE LOCATION	RESULTS	DUPLICATE
01-03-25-320	320	25	TSI	Insulation on Steam Pipes; >2", <6" Diameter Pipes	Room C307, Corridor above Ceiling Outside Room B312	5% Chrysotile, 20% Amosite	
01-03-69-320	320	69	TSI	Mudded Pipe Fittings on Millboard-Insulated Lines <2" Diameter	Room A307, Northwest Corner above Ceiling	40% Chrysotile	60% Chrysotile
01-03-137-321	321	137	MM	Fibrous Drywall	Room B302, Debris Removed from Access to Space Between Walls Along East Side of Hallway into Room w/TV Room	ND	
01-03-168-321	321	168	MM	Construction Adhesive Light Brown Color	Room A342, Soffit Running North/South Near East Side above Metal Pan Ceiling	ND	
01-03-176-322	322	176	MM	Tan Vertical-Textured Stripe Wall Covering	Corner of Corridor into Hemodialysis Wing West Side Next to Water Fountain about 6-9" off Floor	ND	
01-03-93-322	322	93	MM	2' x 2' Ceiling Panel, Drywall w/Vinyl Finish	Room B302A, from Panels in Ceiling	ND	
01-03-119-323	323	119	MM	9" x 9" Floor Tile, Red w/Cream Streaks	Room B305, Southwest Corner Near Floor Penetration	Tile & Mastic 10% Chrysotile	
01-03-169-323	323	169	MM	Gasket Material from Wall Heaters in Kitchen	Room B320, 2nd Trane Unit from Southeast Corner (kitchen)	ND	ND
01-03-138-324	324	138	MM	Plaster Fill Material around Conduit Penetrations through Floor	Room B305, Plaster Material Used to Seal Cable Penetration in Floor, Southwest Corner	ND	
01-03-153-324	324	153	TSI	Debris Left from Previous Activities	Rooms B315 & B318, Laying on Floor in Pipe Area in Wall between Rooms	ND	
01-03-01-325	325	1	MM	1' x 1' Floor Tile, Cream w/Brown Streaks (light and dark)	Room B303B, East Edge of Floor Under Door	Tile & Mastic ND	
01-07-177-325	325	177	TSI	Chrysotile Duct & Insulation	Room B712, Southwest Corner above Ceiling	80% Chrysotile	
01-07-69-326	326	69	TSI	Mudded Pipe Fittings on Millboard-Insulated Lines <2" Diameter	Room B714, Southwest Corner above Ceiling, North Pipe	80% Chrysotile	
01-07-01-327	327	1	MM	1' x 1' Floor Tile, Cream w/Brown Streaks (light and dark)	Room B707, South End Next to Radiator	ND	
01-07-03-328	328	3	MM	Mastic under HA # 1	Mastic under Sample #327	ND	
01-07-178-329	329	178	MM	Mauve & Aqua Spattered Pattern Wall Covering	Room B730B, Northeast Corner about 6" from floor	ND	
01-07-179-330	330	179	MM	1' x 1' Floor Tile, White w/Grey & Brown Flecks	Room 730b, Northeast Corner (floor)	ND	
01-07-180-331	331	180	MM	Mastic under HA # 179	Mastic Beneath #330	ND	

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SAMPLE NO	NO	HA	MATL	HA DESCRIPTION	SAMPLE LOCATION	RESULTS	DUPLICATE
01-07-184-332	332	184	MM	1' x 1' Floor Tile, Olive w/Green & White Streaks	Room A739, Northeast Corner of Floor	Tile 2% Chrysotile, Mastic 5% Chrysotile	
01-07-185-333	333	185	MM	Mastic under HA # 184	Underneath Sample #332	5% Chrysotile	
01-07-181-334	334	181	MM	1' x 1' Floor Tile, Olive w/Brown & White Flecks	Room B733, Northeast Corner of Floor	Tile 2% Chrysotile, Mastic 5% Chrysotile	Tile ND, Mastic 10% Chrysotile
01-07-182-335	335	182	MM	Mastic under HA # 181	Mastic under Sample #334	5% Chrysotile	15% Chrysotile
01-07-187-336	336	187	MM	9" x 9" Floor Tile, Olive w/Green & White Streaks	Room A742, Vestibule Area, Northeast Corner of Floor	ND	
01-07-188-337	337	188	MM	Mastic under HA # 187	Mastic under Sample #336	ND	
01-07-187-338	338	187	MM	9" x 9" Floor Tile, Olive w/Green & White Streaks	Room A743, Northeast Corner	ND	Tile & Mastic ND
01-07-188-339	339	188	MM	Mastic under HA # 187	Mastic under Sample #339	ND	
01-07-197-340	340	197	MM	Tan Weave-Pattern Wall Covering	Room A747, Southeast Corner Just above Cove Base on East Wall	ND	
01-07-196-341	341	196	MM	Brown Fibrous Pressboard	Rooms A747 & A748, Approximate Center of Wall, 10' from Floor	ND	
01-07-194-342	342	194	TSI	Tar Wrap on <2" Domestic	Room A769, Off Supply Line to Ceiling Heater	ND	
01-07-81-343	343	81	MM	1' x 1' Floor Tile, Cream w/Caramel Streaks Pattern	Room A757A, Southwest Corner	ND	
01-07-82-344	344	82	MM	Mastic under HA # 81	Mastic under #334	10% Chrysotile	
01-07-163-345	345	163	TSI	CWS >2" - <6"	Room A764A, Corridor above Ceiling Near Room	ND	
01-07-198-346	346	198	TSI	Mud Patch on Fiberglass Duct Insulation	Room A700, Corridor above Ceiling off Side of Duct Near Room A708	ND	
01-07-184-347	347	184	MM	1' x 1' Floor Tile, Olive w/Green & White Streaks	Room B720, Northeast Corner of Floor	ND	
01-07-185-348	348	185	MM	Mastic under HA # 184	Room B720, Northeast Corner of Floor	10% Chrysotile	
04-01-70-349	349	70	TSI	Straight Run Millboard Insulation <2" Diameter Pipes	Room, 106, Above Ceiling Tile in Approximate Center of Room	2% Chrysotile	10% Chrysotile
04-01-10-350	350	10	SM	Plaster on Expanded Wire Mesh Ceiling	Room 108A, Above Ceiling on West Wall	0.5% Chrysotile	
04-01-06-351	351	6	TSI	Mudded Pipe Fittings on Steam Lines, <2" Diameter Pipes	Room 108B, Elbow in Southeast Corner (above ceiling)	5% Chrysotile	
04-01-226-352	352	226	MM	1' x 1' Floor Tile, Light Grey w/Aqua & Dark Grey Streaks	Room 112, Northeast Corner Behind Door	2% Chrysotile	

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VA Medical Center - Ann Arbor, MI - Sample Locator

SAMPLE NO	NO	HA	MATL	HA DESCRIPTION	SAMPLE LOCATION	RESULTS	DUPLICATE
04-01-227-353	353	227	MM	Mastic under HA # 226	Room 112, Under Heater on North Wall	ND	
04-01-107-354	354	107	MM	1' x 1' Floor Tile, Tan w/Brown & Grey Flecks	Room 103, Southwest Corner under Heater on West Wall	ND	
04-01-108-355	355	108	MM	Mastic under HA # 107	Mastic under 04-01-107-354	ND	
04-01-01-356	356	1	MM	1' x 1' Floor Tile, Cream w/Brown Streaks (light and dark)	Room 114, Stairwell Bottom Level Just North of Stairs	8% Chrysotile	
04-01-03-357	357	3	MM	Mastic under HA # 1	Under 04-01-01-356	ND	
04-01-226-358	358	226	MM	1' x 1' Floor Tile, Light Grey w/Aqua & Dark Grey Streaks	Room 108B, Southwest Corner	9% Chrysotile	
04-01-227-359	359	227	MM	Mastic under HA # 226	Mastic under 04-01-226-358	ND	
04-02-134-360	360	134	TSI	Drain Fittings >2" - <6"	Room 201, Near South End Room	ND	
04-02-228-361	361	228	TSI	Roof Drain Straight Insulation. >2", <6" Black Tar-Like Appearance	Approximate Center of Wall, above Ceiling Tile	ND	
04-CS-144-362	362	144	TSI	New Mud on Newly-Insulated Fiberglass Lines	Room 203A, Southeast Corner above Ceiling	ND	ND
01-B-65-400	400	65	MM	2' x 2' Wall Panels w/Regular-Spaced Holes	Elbow in Northwest Corner (to West) (right) of Door Opening Just Inside the Space	ND	
01-B-72-401	401	72	MM	Mauve Burlap-Pattern Wall Covering	Room B17, Storage Northwest Corner, 5' High	10% Chrysotile	40% Chrysotile
01-B-63-402	402	63	MM	2' x 4' Ceiling Tile, White w/Eight Raised Panels	Room B12, Southwest Wall from Corridor, 3' from Floor	ND	
01-B-75-403	403	75	TSI	Black Cork Pipe Insulation w/Tan Seams	Room B12, Northwest Corner of Ceiling from Corridor	ND	
01-B-130-404	404	130	SM	Spray-On Insulation	Room B31, Shipping & Receiving Center of West Wall, 5' Up	ND	
01-B-128-405	405	128	MM	Linoleum, White w/Blue, Brown & Tan Specks	Room E102, Electrical Closet, Center of Ceiling	ND	
01-B-129-406	406	129	MM	Mastic under HA # 128	Room E119, Exam Room	ND	
01-B-134-407	407	134	TSI	Drain Fittings >2" - <6"	Room E119, Exam Room	ND	
01-B-66-408	408	66	MM	1' x 2' Ceiling Tile, White Fibrous (old, above ceiling in sacristy)	Room A2A, Electrical Room Near North Wall, 12' High	ND	
01-B-131-409	409	131	MM	Linoleum, Blue w/Grey and Dark Specks	Room B18, Sacristy above New Ceiling	ND	
01-B-132-410	410	132	MM	Mastic under HA # 131	Room B18, A28 Morgue	ND	

VA Medical Center - Ann Arbor, MI - Sample Locator

SAMPLE NO	NO	HA	MATL	HA DESCRIPTION	SAMPLE LOCATION	RESULTS	DUPLICATE
01-B-09-411	411	9	TSI	Insulation on Domestic Pipe Straight Runs, <2" Diameter Pipes	Room B25, Center of South Wall, 5' Up	ND	
01-B-18-412	412	18	TSI	Mudded Pipe Fittings on Domestic Water Lines, <2" Diameter Pipes	Room B25, Center of South Wall, 10' Up	40% Chrysotile	
01-B-76-413	413	76	MM	2' x 4' Ceiling Tile, White Lay-In w/Random Dotted Pattern	Room A12A, Restroom Center of Ceiling	ND	
01-B-145-414	414	145	TSI	Cork on Brine Line <2"	Room B31A, Refrigerator East Wall, 5' Up	ND	
01-B-01-415	415	1	MM	1' x 1' Floor Tile, Cream w/Brown Streaks (light and dark)	Room B31, Corner West Floor	Tile & Mastic ND	
01-B-03-416	416	3	MM	Mastic under HA # 1	Room B31, Corner West Floor	ND	
01-B-73-417	417	73	MM	Tan w/Blue Specks Wallpaper	Room B9, Lower Corner South Wall	ND	
01-B-64-418	418	64	MM	1' x 1' Floor Tile, Tan w/White & Grey Specks	Room B12, Northwest Corner Floor	Tile & Mastic ND	
01-B-64A-419	419	231	MM	Mastic under HA # 64 (originally listed as 64A)	Room B12, Northwest Corner Floor	5% Chrysotile	
01-B-107-420	420	107	MM	1' x 1' Floor Tile, Tan w/Brown & Grey Flecks	Room B26, E2 Center of Room Floor	Tile ND, Mastic 5% Chrysotile	
01-B-108-421	421	108	MM	Mastic under HA # 107	Room B26, E2 Center of Room Floor	5% Chrysotile	
01-B-128-422	422	128	MM	Linoleum, White w/Blue, Brown & Tan Specks	Room A28, Corner West Wall	ND	
01-B-129-423	423	129	MM	Mastic under HA # 128	Room A28, Corner West Wall	ND	
01-B-25-424	424	25	TSI	Insulation on Steam Pipes; >2" , <6" Diameter Pipes	Room A28, Corner West Wall	ND	
01-B-26-425	425	26	TSI	Mudded Pipe Fittings on Steam Lines; >2" , <6" Diameter Pipes	Room B10, Center Room Overhead	ND	
01-SB-171-426	426	171	TSI	Insulation on Domestic Water Tank	Northwest Column N14, 7' South, 20' East, 5' High	ND	
01-SB-172-427	427	172	TSI	Insulation on Steam Tank	Northwest Column N15, 10' South, 6' East, 5' High	ND	
01-SB-127-428	428	127	MM	Cork Ceiling 3" Deep	Northwest Column N15, 0' South, 0' East, 12' High	ND	
1-SB-164-429	429	164	TSI	CWS Fittings >2" - <6"	Northwest Column M16, 8' South, 5' East, 5' High	ND	
01-SB-162-430	430	162	TSI	Brine Fittings >2" - <6"	Northwest Column M16, 8' South, 5' East, 5' High	ND	
01-SB-163-431	431	163	TSI	CWS >2" - <6"	Northwest Column M14, 2' South, 4' East, 10' High	ND	

VA Medical Center - Ann Arbor, MI - Sample Locator

SAMPLE NO	NO	HA	MATL	HA DESCRIPTION	SAMPLE LOCATION	RESULTS	DUPLICATE
01-SB-166-432	432	166	TSI	Steam Pipe >6"	Northwest Column O12, 6' South, 6' East, 10' High	ND	
01-SB-165-433	433	165	TSI	Steam Fittings >6"	Northwest Column O16, 4' South, 16' East, 6' High	ND	
01-SB-26-434	434	26	TSI	Mudded Pipe Fittings on Steam Lines; >2", <6" Diameter Pipes	Northwest Column O14, 0' South 8' East, 4' High	ND	
01-SB-167-435	435	167	TSI	Cold Water Fitting w/Black Tar >6"	Northwest Column O14, 0' South, 3' East, 5' High	ND	ND
01-SB-46-436	436	46	TSI	LPS Fittings, >2" - <6" Diameter	2' West of D9, 2' High	40% Chrysotile	
01-SB-189-437	437	189	TSI	Vacuum Mud Fitting <2"	2' West of D9, 1' High	40% Chrysotile	
01-SB-189-438	438	189	TSI	Vacuum Mud Fitting <2"	South 10' of C7, West 3', 3' High	2% Chrysotile	30% Chrysotile
01-SB-46-439	439	46	TSI	LPS Fittings, >2", <6" Diameter	South 6' of C7, West 4', 4' High	5% Chrysotile	
01-SB-09-440	440	9	TSI	Insulation on Domestic Pipe Straight Runs, <2" Diameter Pipes	North 2' of B6, 4' High	40% Chrysotile	
01-SB-18-441	441	18	TSI	Mudded Pipe Fittings on Domestic Water Lines, <2" Diameter Pipes	4' North of B6, 3' West, 4' High	40% Chrysotile	
01-SB-214-442	442	214	TSI	Drip Return Fitting >2", <6"	8' East of G4, 4' High	40% Chrysotile	
02-B-215-443	443	215	MM	1" Wide Fibrous Duct Tape	Above Door from B1 to B2 & above West Corner on Duct	75% Chrysotile	85% Chrysotile
02-B-107-444	444	107	MM	1' x 1' Floor Tile, Tan w/Brown & Grey Flecks	Bathroom in Basement	ND	
02-B-108-445	445	108	MM	Mastic under HA # 107	Bathroom in Basement	ND	
02-02-216-446	446	216	MM	Linoleum, White w/Blue, Red, Purple & Green Specks	2nd Floor Bathroom	ND	
02-02-217-447	447	217	MM	Mastic under HA # 216	2nd Floor Bathroom	ND	
02-01-218-448	448	218	MM	Linoleum, White w/Tan Streaks	1st Floor West Side	ND	
02-01-219-449	449	219	MM	Mastic under HA # 218	1st Floor West Side	ND	
02-01-220-450	450	220	MM	Linoleum, White w/5" Grey-Outline Squares	1st Floor Kitchen	ND	
02-01-221-451	451	221	MM	Mastic under HA # 220	1st Floor Kitchen	ND	
T3-1ST-107-452	452	107	MM	1' x 1' Floor Tile, Tan w/Brown & Grey Flecks	Bathroom	ND	
T3-1ST-108-453	453	108	MM	Mastic under HA # 107	Bathroom	ND	
03-B-18-454	454	18	TSI	Mudded Pipe Fittings on Domestic Water Lines, <2" Diameter Pipes	Room 016, Building 3 Basement, Northwest Corner, 6' High	ND	
03-B-09-455	455	9	TSI	Insulation on Domestic Pipe Straight Runs, <2" Diameter Pipes	Room 01A, Building 3, Hallway in Front of Room, above Ceiling	2% Chrysotile	

VA Medical Center - Ann Arbor, MI - Sample Locator

SAMPLE NO	NO	HA	MATL	HA DESCRIPTION	SAMPLE LOCATION	RESULTS	DUPLICATE
03-01-07-456	456	7	MM	1' x 1' Floor Tile, Tan w/Brown & White Streaks	Building 3, Female Restroom	2% Chrysotile	
03-01-08-457	457	8	MM	Mastic under HA # 7	Building 3, Female Restroom	ND	
01-09-130-458	458	130	SM	Spray-On Insulation	Room A926A, Southwest Corner	ND	
03-02-134-458	458	134	TSI	Drain Fittings >2", <6"	Building 3, 2nd Floor, Stairs above Ceiling	ND	
01-09-130-459	459	130	SM	Spray-On Insulation	Room A926A, Northwest Corner	ND	
01-09-130-460	460	130	SM	Spray-On Insulation	Room A926A, Northwest Corner	ND	
22-G-144-461	461	144	TSI	New Mud on Newly-Insulated Fiberglass Lines	Room G1, Building 22, Northwest Corner, 8' South, 15' East, 12' High	ND	
22-G-20-462	462	20	MM	1' x 1' Floor Tile, White w/Grey Flecks	Room G1, Building 22, Northwest Corner	15 % Chrysotile	8% Chrysotile
22-G-23-463	463	23	MM	Mastic under HA # 20	Room G1, Building WW, Northwest Corner	10% Chrysotile	
22-G-01-464	464	1	MM	1' x 1' Floor Tile, Cream w/Brown Streaks (light and dark)	Room G12, Building 22, Northwest Corner	ND	
22-G-03-465	465	3	MM	Mastic under HA # 1	Room G12, Building 22, Northwest Corner	15% Chrysotile	
22-02-228A-466	466	232	TSI	Steam Mud Fitting >2"-6", Bldg. 22 (Originally listed as 228A)	Mechanical Room, Building 22, Southwest Corner, 7' High	ND	ND
22-02-229-467	467	229	TSI	Domestic Mud Fitting >2", Bldg. 22	Mechanical Room, Building 22, Southwest Corner, 7' High	ND	
22-02-230-468	468	230	TSI	Condensate Tank Mud, Bldg. 22	Mechanical Room, Building 22, Southeast Corner, 3' High	ND	
01-01-233-500	500	233	MM	9" x 9" Floor Tile, Green w/White Streaks	Room A116 - Under Carpeting @ Radiator along South Wall	7% Chrysotile	
01-01-233-501	501	234	MM	Mastic under HA # 233	Room A116 - Under Carpeting @ Radiator along South Wall	<1% Chrysotile	
01-01-233-501	501	233	MM	9" x 9" Floor Tile, Green w/White Streaks	Room A185 - Under Carpeting @ Doorway between A186 & A185	5% Chrysotile	
01-01-233-501	501	234	MM	Mastic under HA # 233	Room A185 - Under Carpeting @ Doorway between A186 & A185	ND	
01-01-235-502	502	235	MM	9" x 9" Floor Tile, Red w/Cream & Black Streaks	Room A179 - Under Carpeting @ Doorway Entry - South Corner	8% Chrysotile	
01-01-235-502	502	236	MM	Mastic under HA # 235	Room A179 - Under Carpeting @ Doorway Entry - South Corner	ND	
01-01-235-503	503	235	MM	9" x 9" Floor Tile, Red w/Cream & Black Streaks	Room A183 - Under Carpeting @ Doorway between A183 & A182	5% Chrysotile	
01-01-235-503	503	236	MM	Mastic under HA # 235	Room A183 - Under Carpeting @ Doorway between A183 & A182	ND	

TAB 3

VA EXISTING LEAD PAINT SURVEY

TEOC

Tillotson Environmental Occupational Consulting

1423 Keystone Drive
Suite 220
Lansing, MI 48911
(517) 887-0500
FAX (517) 887-1833

July 25, 1997

HARLEY ELLINGTON DESIGN
26913 NORTHWESTERN HWY STE 200
SOUTHFIELD MI 48034-3476

ATTN: Clifford H. Snyder

RE: Summary Report for the Lead Paint Detection Survey Conducted at Veterans Medical Center, Main Building #1, Ann Arbor, Michigan.

Dear Mr. Snyder:

Thank you for providing TEOC (Tillotson Environmental Occupational Consulting) the opportunity to provide environmental/occupational consulting for Harley Ellington Design/Veterans Administration Facilities.

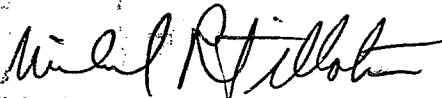
Enclosed is the report for the Lead Paint Detection Survey conducted on October 1996 through May 1997 at the Veterans Medical Center, Main Building #1, Ann Arbor, Michigan. We have provided a computer database copy of the survey report and nine hard copies that include the following:

- Survey Report
- Building/Room Inventory of Lead Based Paint Surfaces
- All Homogeneous Areas
- Sample Log Locator
- Analytic Results
- Quality Control Sample Results

If you have questions regarding this report, please contact me at (517) 887-0500. TEOC looks forward to serving the environmental/occupational needs of Harley Ellington on future projects.

Sincerely,

TEOC (Tillotson Environmental Occupational Consulting)



Michael R. Tillotson, CIH, CHMM
President

State of Ohio Lead Inspector/Risk Assessor License # OH 001388

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**VETERANS AFFAIRS MEDICAL CENTER
ANN ARBOR, MICHIGAN**

**LEAD PAINT SURVEY REPORT
BUILDING NO. 1**

FOR

**HARLEY ELLINGTON DESIGN
SOUTHFIELD, MICHIGAN**

Prepared By:

**TILLOTSON ENVIRONMENTAL OCCUPATIONAL CONSULTING
LANSING, MICHIGAN**

JULY 1997

FINAL REPORT
FOR
THE LEAD PAINT INSPECTION CONDUCTED AT:
VETERANS AFFAIRS MEDICAL CENTER
BUILDING NO. 1
ANN ARBOR, MICHIGAN

For
Harley Ellington Design

by
Tillotson Environmental Occupational Consulting
Lansing, Michigan

VA PROJECT NO. 506-027

INSPECTION DATES
SEPTEMBER 21, 1996 THRU MAY 1, 1997

INSPECTION CONDUCTED BY:

BRYANT J WILKE R.S.
Certified Lead Inspector
License No. L-4548
Expires 01/31/98

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Floor No.

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Executive Summary

The Ann Arbor Veterans Affairs Medical Center Building No. 1 located at 2215 Fuller Avenue, Ann Arbor, Michigan, underwent a complete room by room lead detection survey during September 1997 through May 1, 1997. Each room was inspected for painted surfaces and measured with a lead in paint spectrum analyzer for lead content. The lead in paint survey was prompted by future renovation activities at this facility.

The room by room survey included each room and adjacent sub rooms, common areas such as corridors, and restrooms. All mechanical and storage areas were surveyed as well. The room surveys included all paint surfaces accessible to the inspector. All accessible sub-ceilings were temporarily removed in order to survey for paint surfaces above the finished drop ceiling. Pan or metal plate ceilings were not removed. Multiple ceiling measurements were required when both sub and structural ceilings were identified as painted. Similar construction components, as well as design factors throughout the facility, was evident, however, varying numbers of components were measured per room dependent upon the number of actual painted surfaces found. Several common or like components were grouped into homogeneous components needing less spectrum measurements, nevertheless confirming the component's paint content. A list of these components is available within the report. No exterior components were included in the lead paint detection survey.

The room inventories reveal painted surfaces containing lead as a Positive in the final result column found on the right hand side of each inventory sheet. A positive spectrum sample is defined as having a lead content of equal to or greater than 1.0 mg/cm^2 or equal to or greater than 0.5% by weight if sampled by paint chip and analyzed in a laboratory. All negative results are indicated by (---) and confirmed negatives by Negative. All sample data has been reviewed to confirm the final result. Approximately 21,000 measurements or assays have been collected with approximately 150 confirmation paint chip samples.

A homogeneous list of positive building components has been prepared to identify the most common components found to be lead paint containing throughout the building. A number of these components may have an individual negative result in their individual data sheet. For instance, the majority of stairwell components were found to be positive with other stairwell areas having negative similar components. It was discovered that the worn thin re-painted areas had negative results whereas thick non-worn areas were consistently positive. An underlying coat of orange paint appears to be the paint producing the positive results. The underlying orange color can be found in several components in the building. Another example is the building expansion joints. These joints found throughout the building have an orange color surface. Due to its irregular surface pattern, the spectrum analyzer was unable to measure against that surface. Paint chip sampling was unsuccessful as well, therefore a modified dust wipe procedure was completed to determine a qualitative result. The results indicated that the orange underlying paint is positive for lead.

The spectrum analyzer or X-Ray fluorescence unit (XRF) is remarkably accurate in its measurement analysis. The results column in the room data sheets can be used to identify lead below the standard of 1.0 mg/cm^2 in an event a circumstance requires knowledge if lead is present or not present regardless as to what standard is adhered to.

The identifying of lead components throughout a lead detection survey is a catalyst in developing further protocols in worker protection management programs for potential lead exposure during maintenance, redecorating and demolition projects. The lead survey can further be utilized in identifying those areas or overall components that could benefit by using specific management techniques in controlling lead painted surfaces should such controls be necessary.

1.0 Introduction

The firm Harley Ellington Design, 26913 Northwestern Highway, Suite 200, Southfield, Michigan, contracted the services of Tillotson Environmental Occupational Consulting, 1423 Keystone Drive, Suite 220, Lansing, Michigan 48911 to complete a room by room lead in paint survey at the Ann Arbor Veterans Affairs Medical Center (V.A.M.C.), 2215 Fuller Road, Ann Arbor, Michigan 48105. The V.A.M.C. Ann Arbor facilities consist of thirty-four permanent buildings. The survey scope focused entirely on the largest of the thirty-four buildings identified as building No. 1. Building No. 1 consists of the main facility within the V.A.M.C. grounds and is utilized for all patient care as well as patient services.

Building No. 1 contains a total of eleven (11) floors with nine (9) floors being utilized as patient areas including offices, treatment, research, maintenance, and storage rooms. The tenth and eleventh floors serve as the main mechanical rooms for the entire facility.

The lead paint detection survey encompassed the entire Building No. 1 by surveying room to room starting at the lower level floor and moving upward by floor until the entire facility was surveyed. Each room would be surveyed utilizing a Niton XL 309 spectrum analyzer lead detector referred to as an x-ray fluorescence unit or XRF unit. The Niton XL 309 performance characteristic sheets are located in Appendix A.

The XL 309 measures lead by using both the L x-rays and the K x-rays lines of lead. The L x-ray is used to measure the lead concentration. The K x-rays are used to verify ambiguities and determine whether real thick paint may or may not contain lead.

The L x-ray lines form a unique set of energies, known as L alpha, L beta, and L gamma lines. Each of these lines are displayed on the XL 309 and recorded. The alpha, beta and gamma lines have energies of 10.5 keV, 12.6 keV, and 14.7 keV respectively. A complete x-ray emission energies list is provided in Appendix B.

These energy lines are plotted as dark bars or bands similar to bar graphs. The first left dark band is the 10.5 keV region; the middle band is the 12.6 keV region; the far right band is the 14.7 keV region. Lead is the only element that produces both 10.5 keV and 12.6 keV peaks. The presence of alpha and beta peaks is therefore an unambiguous indication lead is present in the painted surface. All positive spectrum data has been provided in the room data section. Section 3.0 explains the proper method in determining whether lead is present from the XRF assay. Spectrum illustrations can be found in figure 4, page 15.

2.0 Building Components

A building component is a building's structural parts. For example, a door is a single component. Other components consist of walls, door frames, window casing (trim), structural I-beams, pipes and various odd components utilized as finish products throughout the facility.

As with all commercial structures, components are replicated and generic to the building and therefore grouped as homogeneous components. Each homogeneous component had one assay completed rather than the 2 to 3 traditionally required in determining whether the component is negative or positive for containing lead above the residential HUD standard of 1.0 mg/cm². Each component is then compared to all assays collected for that specific component in determining its result classification. The following items list the building components classified as homogeneous components.

Homogeneous Components Results Based On Percentages

Results as Percent	Window Frames	Pipes (All)	Radiator Covers	Drop Ceilings	Pan Ceilings	Air Diffuser	Blinds (Metal)
Positive	80%	34%	2%	3%	1%	2%	0%
Negative	18%	68%	97%	95%	98%	95%	98%
Inconclusive	2%	3.6%	1%	2%	1%	3%	2%

2.1 Building Component Selection

All components for assay collection were selected by the inspector during the room by room survey. Component selection was based on painted surfaces accessible to the inspector by visual observation during the room visit. All components, including any homogeneous components, were assayed in an attempt to gather as much data as possible in determining the component's lead paint content. Components above accessible ceiling tiles were also inspected and measured if painted, in an attempt to reveal components containing lead paint above suspended ceilings. The survey utilized a specific methodology in its testing approach in order to maintain valid data retrieval as well as manage the amount of data being collected over the entire building space. Each room survey began with all wall components and finished with a ceiling measurement. Occasionally, walls with no paint surfaces were found in closet spaces where the most related component would be assayed first.

This approach assured that all rooms would be tested equally by component and to assure room surveys could be identified should electronic failure corrupt data entries as well as future data retrieval.

2.2 Component Labeling

Normal HUD protocol would require the labeling of each room with identifying components as compared to the street side of the building. Due to this facility having several corridors spanning a large area, a modification of the HUD guidelines was created. Each room entrance off the corridor has been identified as a primary wall or wall A with subsequent walls being labeled clock-wise with alphabetic an identifier. Figures 2 and 3 on pages 3 & 4 respectively illustrate the labeling method used. This labeling method allowed the procedure to be effective in assuring all components would be assayed without missing potential painted surfaces. All accessible suspended ceilings were inspected for paint surfaces above the ceilings. Several rooms with no ceiling measurement identifies rooms which had soft, glued-on ceiling tiles instead of lay in or pan tile ceilings.

Homogeneous components are labeled with an asterisk (*) in the room data sheets. Each room report has multiple assays for components and single assays for homogeneous components. All components have been identified with a proper building construction name for easy identification.

Several components are labeled separately for assay purposes. These components should be recognized as whole components when reviewing the room data sheets. Components such as door casings and jambs are equal for all standard purposes because its makeup is a one piece commercial grade door frame. The only exception is if two different color paints were identified on one side vs. the other side. Multiple assays would be performed if this were the case. Another similar component example are window frames or trim which are made up of casings, stops, stools, headers and mullions.

V.A.M.C. ROOM ILLUSTRATION

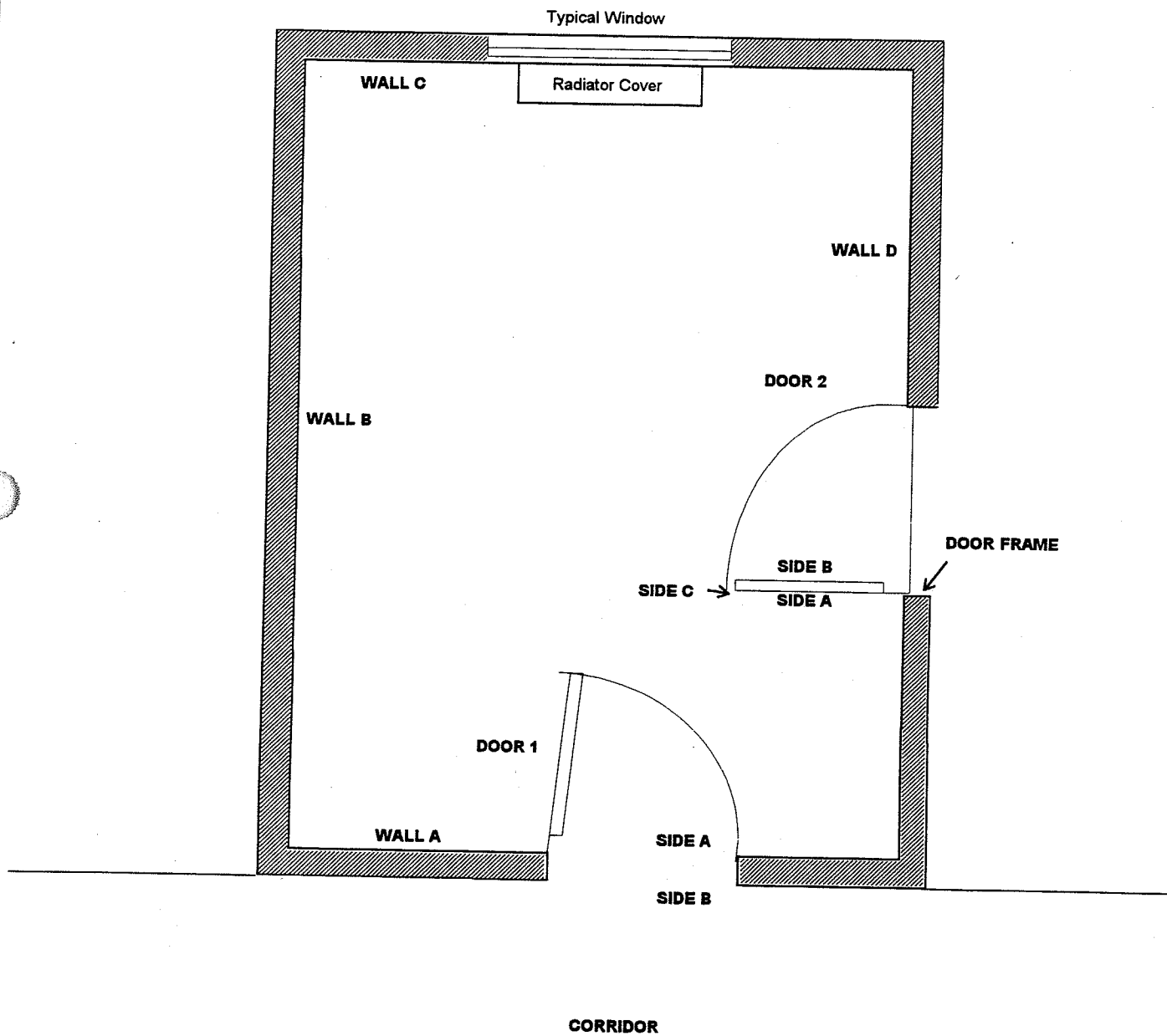


figure # 1

V. A. M. C. COMPONENT ILLUSTRATION

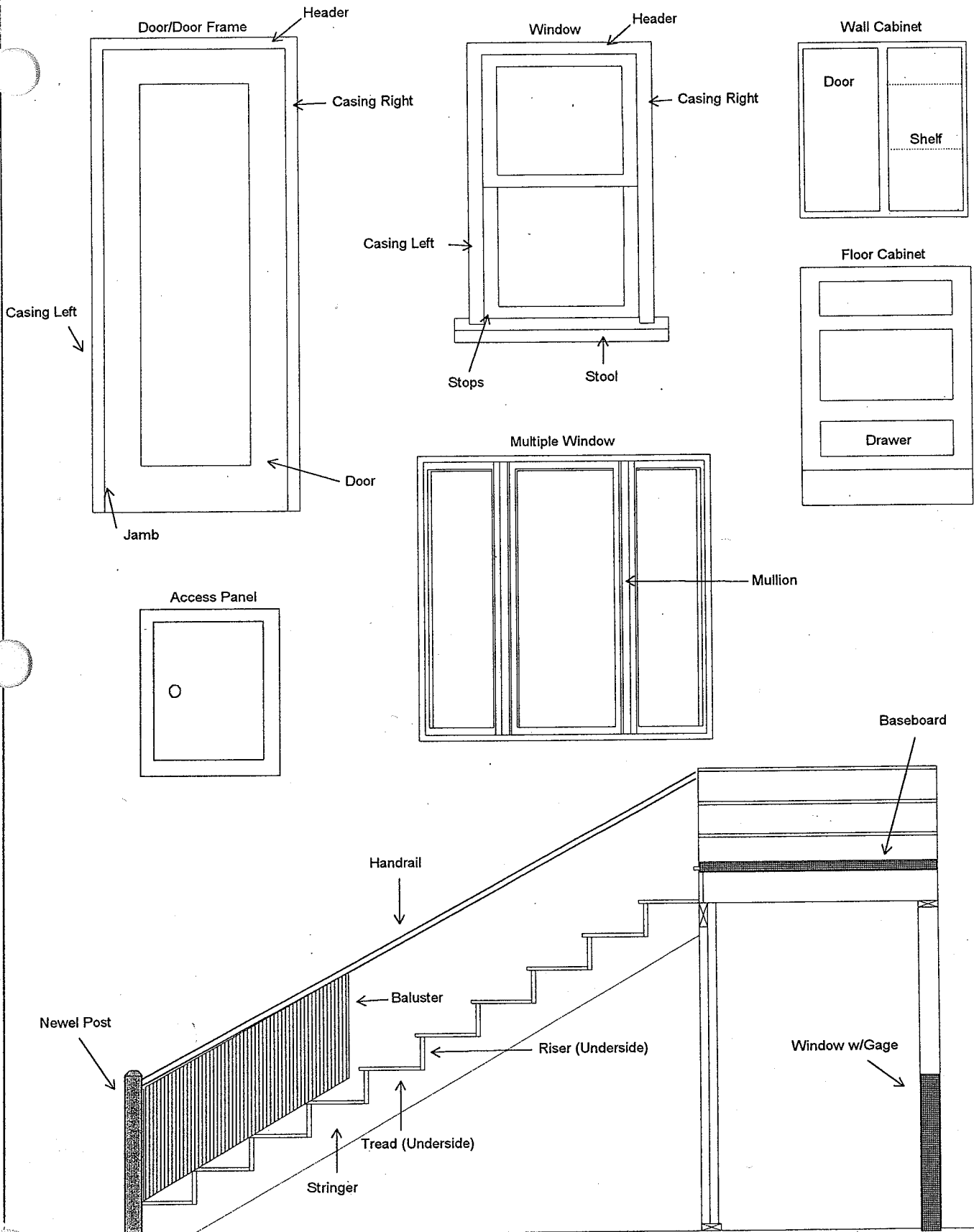


Figure # 2

3.0 Final Result Indicator

Building components require at least two or more assay measurements to determine whether a lead based paint had been used on the component surface. The assay measurements are either numerically averaged for a result or provided with a negative or positive result indicator. In order to simplify and create an effective survey tool for future utilization, the latter was chosen as the final indicator in determining whether a building component is negative or positive in containing lead. The final result is compared to the established HUD standard of 1 mg/cm^2 . Any component below the 1.0 mg/cm^2 is considered negative and any component equal to or above the 1.0 mg/cm^2 standard is considered positive. A combination of the results determines whether the entire component in that room is negative or positive. A combination requires at least two measurements to be negative for a final negative result or two positive results to be positive for a final positive result. The non-numerical result indicator allows for negative and positive individual result comparisons to simplify the determination whether the component has lead containing paint above the standard. The Niton XL 309 however, allows the user to determine whether lead is present lower than the standard of 1.0 mg/cm^2 . By actually reviewing the assay data, determination can be made whether lead is present but below the standard.

Classifications of the XRF result for a given testing combination is obtained by reviewing and combining the individual results of the three L-shell readings as follows:

- A POSITIVE classification is obtained if at least two of the three individual L-readings are classified as positive.
- A NEGATIVE classification is obtained if at least two of the three individual L-readings are classified as negative.
- An INCONCLUSIVE classification is obtained if at least two of the three individual L-readings are classified as inconclusive.

Project books 2 thru 5 contain the individual room results. Each book contains data for that specified floor by room. All results are reported under Final Result column listed under the furthest right hand column of each data sheet. Positive results are listed as POS. Negative results are listed as NEG only when a complete review of the data has occurred due to conflicting assay results and/or confirmation data is included. All assays containing a (...) under the Final Result column are unequivocally negative.

Assays with a NC or Non confirm reveal assay data that is not confirmable at this time and additional paint chip sample collection and analysis is required.

In addition, each positive result has its L-spectrum on a separate page following the individual room page(s). The L-spectrum confirms that lead containing paint has been identified on that specified component and should be considered positive either equal to or above the HUD standard or 1 mg/cm^2 . A complete interpretation of the methodology in determining result classification is included in the XRF interpretation section 5.1 found on page 11.

3.1 Inconclusive Result Verification

XRF assays with inconclusive results are required to have a confirmation paint chip sampling. Confirmation sampling includes the collection of a paint chip sample at least 2 grams in weight for an analytical procedure known as atomic absorption analysis. Due to the various paint thicknesses found during the survey, different size paint chip samples were required in order to facilitate the analytical process. A standard 4x4 inch paint chip was collected for thin filmed paints and a 2x2 inch for thicker paint film accumulations. All paint chip samples were collected utilizing HUD and EPA paint chip sampling procedures found in the HUD guidelines. All inconclusive results are verified by paint chip sampling and laboratory lead content determination by atomic absorption.

4.0 Paint Chip Sample Procedures

All paint chips were collected by utilizing a heating method in order to remove the sample without any attached substrate. Each sample was heated with a heat gun until the painted surface appeared ready for removal. A razor knife was used to remove the heated area from its substrate. Sampling equipment was decontaminated prior to and after each sample collection. Samples were stored in plastic baggies, labeled and recorded on the chain of custody forms supplied by the laboratory. All samples were analyzed by EMSL Analytical Laboratories, 212 S. Wagner Road, Ann Arbor, Michigan. Sample results can be found in Appendix C. All paint chip results have been incorporated into the XRF room data sheets.

4.1 Components Sampled by Paint Chip Exclusively

Paint chip samples have been collected to verify low concentrations of lead determined by the XRF. Several paint chip pipe samples from heating pipes have been collected to verify the presence of lead paint as well. All heating pipes results are as follows:

RADIATOR PIPE PAINT CHIP SAMPLES **Homogeneous Component**

Sample No.	Floor	Result % (wt.)	Final Result
3-2	Third	0.26	NEG
3-3	Third	0.22	NEG
6-3	Sixth	0.32	NEG
6-4	Sixth	0.34	NEG

4.2 Component Sampled by Dust Wipe Procedure

A qualitative sample was collected by dust wipe for the common floor expansion joints found throughout the building. The expansion joint is orange in color and due to its surface irregularities, it was impossible to collect an assay with the XRF unit. Standard paint chip sampling did not work either. The paint would scrape into a fine dust making it difficult to collect. Heating the surface caused the dust to spread away from the sample area. Therefore, a qualitative dust wipe sample was completed in order to obtain information on this specific component. A one inch by one inch painted surface was scraped until it was loose enough to be collected with a wipe. The result indicates 16,422 ug of Pb per wipe. The HUD lead dust standard for floors is equal to 200 ug/sq ft. Thus, the qualitative procedure clearly reveals the orange expansion joints to be lead containing paints.

Sample No.	Floor	Result ug/wipe	Final Result
7-4	Fourth	16422	POS

5.0 Homogeneous Positive Components

The following building components have been sampled by X-Ray Fluorescence (XRF) technology and found to be positive for lead paint equal to or above the Department of Housing and Urban Development (HUD) standard of 1.0 mg/cm². This list is not an inclusive list of all the positive components, it is the most common homogeneous building components found throughout building No. 1 which contain lead painted surfaces:

SUB BASEMENT

Stairway hand rail - black/orange
Stairway treads - black/orange
Window frames - brown
Ladders (permanent) - grey
Door/Hatchways leading to crawl spaces - grey
Gage backboard - black

BASEMENT

I Beam, recreational area - tan
Window frames - light - off white
Piping, sprinkler system piping - off white/orange
Piping found in sub ceiling - 1)red, 2)orange
Piping, Wastewater pipes leading to floors above - off white
Pipe hangers - orange
Walls & Ceiling in room A-12 (linen services) - off white/grey
Shelf closet room B-18 (Chaplin office) - light green
Tile baseboard in restrooms - yellow (large bownose)
Ceiling diffuser room B-11
Metal window frames with metal security fences
Electrical panels (relatively old units) see individual room data
Newel post - brown/orange
Baluster - brown/orange
Stairway stringers - black/orange
Wall air registers - see individual room data
Stairway tread (underside)
Stairway risers (underside)

FIRST FLOOR

Window frames - off white
Baseboard tile - yellow (large bownose)
Pipes - sprinkler system - off white/orange
Pipe hangers - orange
Pipes - 1)Red, 2)orange
Pipes, exposed wastewater pipes in stairwell areas
Electric panels, see individual room data
Newel post - brown/orange
Balusters - brown, black/orange
Stairway treads (underside)
Stairway risers (underside)
Stairway baseboards - brown
Stairway stringer - brown, black/orange

SECOND FLOOR

Window frames - off white
Baseboard tile - yellow (large bownose)
Pipes - sprinkler system - off white/orange
Pipe hangers - orange
Pipes - 1)red, 2)orange
Pipes, exposed wastewater pipes in stairwell areas
Metal window frames with metal security fences
Newel post - brown/orange
Balusters - brown, black/orange
Stairway treads (underside)
Stairway risers (underside)
Stairway baseboards - brown
Stairway stringer - brown, black/orange

THIRD FLOOR

Window frames - off white
Baseboard tile - yellow (large bownose)
Pipes - sprinkler system - off white/orange
Pipe hangers - orange
Pipes - 1)red, 2)orange
Pipes, exposed wastewater pipes in stairwell areas
Metal window frames with metal security fences
Newel post - brown/orange
Balusters - brown, black/orange
Stairway treads (underside)
Stairway risers (underside)
Stairway baseboards - brown
Stairway stringer - brown, black/orange

FOURTH FLOOR

Window frames - off white
Baseboard tile - yellow (large bownose)
Pipes - sprinkler system - off white/orange
Pipe hangers - orange
Pipes - 1)red, 2)orange
Pipes, exposed wastewater pipes in stairwell areas
Metal window frames with metal security fences
Newel post - brown/orange
Balusters - brown, black/orange
Stairway treads (underside)
Stairway risers (underside)
Stairway baseboards - brown
Stairway stringer - brown, black/orange

FIFTH FLOOR

Window frames - off white
Baseboard tile - yellow (large bownose)
Pipes - sprinkler system - off white/orange
Pipe hangers - orange
Pipes - 1)red, 2)orange
Pipes, exposed wastewater pipes in stairwell areas
Metal window frames with metal security fences
Newel post - brown/orange
Balusters - brown, black/orange
Stairway treads (underside)
Stairway risers (underside)
Stairway baseboards - brown
Stairway stringer - brown, black/orange

SIXTH FLOOR

Window frames - off white
Baseboard tile - yellow (large bownose)
Pipes - sprinkler system - off white/orange
Pipe hangers - orange
Pipes, exposed wastewater pipes in stairwell areas
Metal window frames with metal security fences
Newel post - brown/orange
Balusters - brown, black/orange
Stairway treads (underside)
Stairway risers (underside)
Stairway baseboards - brown
Stairway stringer - brown, black/orange

SEVENTH FLOOR

Window frames - off white
Baseboard tile - yellow (large bownose)
Pipes - sprinkler system - off white/orange
Pipe hangers - orange
Pipes, exposed wastewater pipes in stairwell areas
Metal window frames with metal security fences
Newel post - brown/orange
Balusters - brown, black/orange
Stairway treads (underside)
Stairway risers (underside)
Stairway baseboards - brown
Stairway stringer - brown, black/orange

EIGHTH FLOOR

Window frames - off white
Baseboard tile - yellow (large bownose)
Pipes - sprinkler system - off white/orange
Pipe hangers - orange
Pipes, exposed wastewater pipes in stairwell areas
Metal window frames with metal security fences
Newel post - brown/orange
Balusters - brown, black/orange
Stairway treads (underside)
Stairway risers (underside)
Stairway baseboards - brown
Stairway stringer - brown, black/orange

NINTH FLOOR

Window frames - off white
Baseboard tile - yellow (large bownose)
Pipes - sprinkler system - off white/orange
Pipe hangers - orange
Pipes, exposed wastewater pipes in stairwell areas
Metal window frames with metal security fences
Newel post - brown/orange
Balusters - brown, black/orange
Stairway treads (underside)
Stairway risers (underside)
Stairway baseboards - brown
Stairway stringer - brown, black/orange
Ceiling I-Beams - orange

TENTH FLOOR (MECHANICAL ROOM)

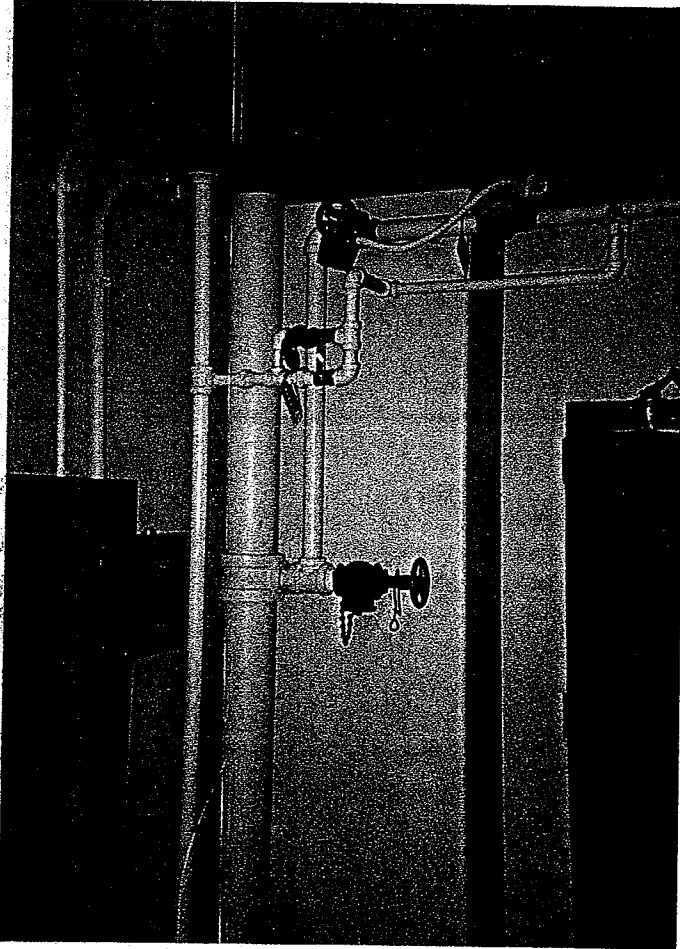
Window Frames - wood
Pipes - grey
Stair Ways - metal

ELEVENTH FLOOR (ELEVATOR CONTROL ROOM)

Window Frames - wood
Floor - grey
Elevator Motors - dark green
Water Tanks - off white

HOMOGENEOUS POSITIVE COMPONENTS
PHOTOGRAPHS

Typical Stairwell
Fire Suppression Pipe Configuration
Positive: 1.25" & 8" Pipes

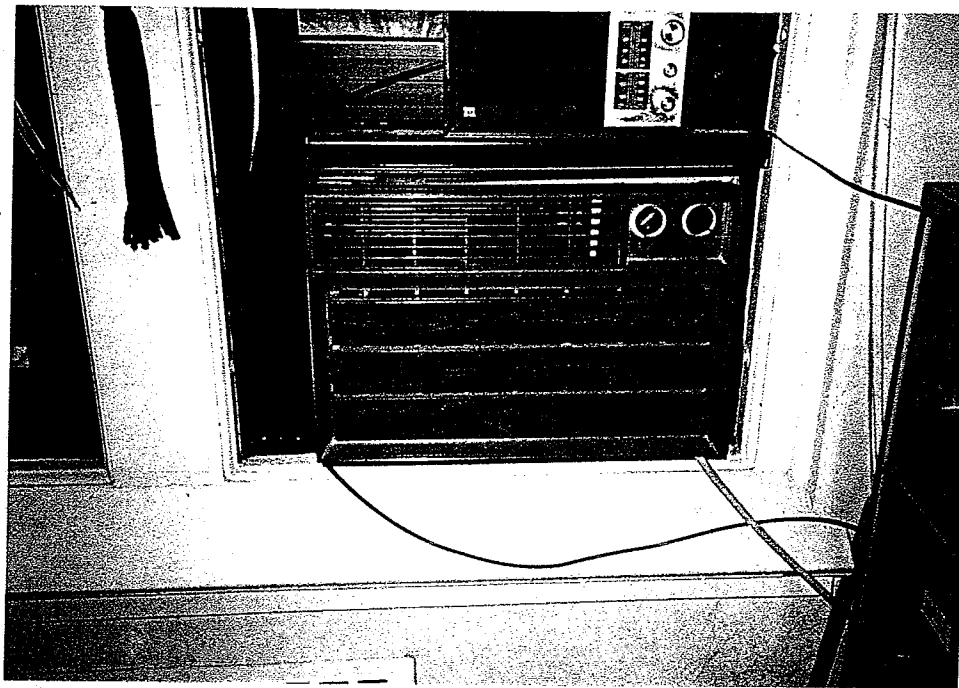
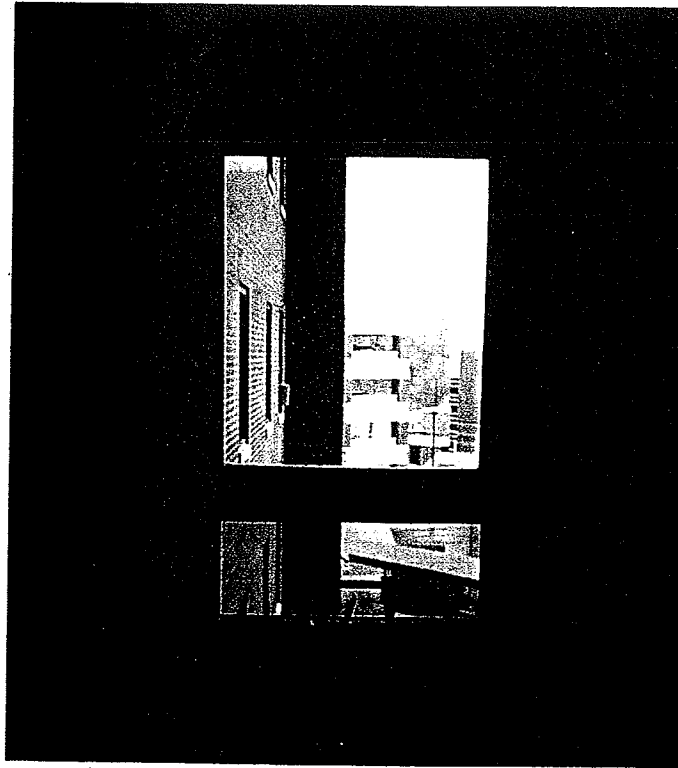


Typical Fire Equipment Room
Positive: 1.25" Pipe



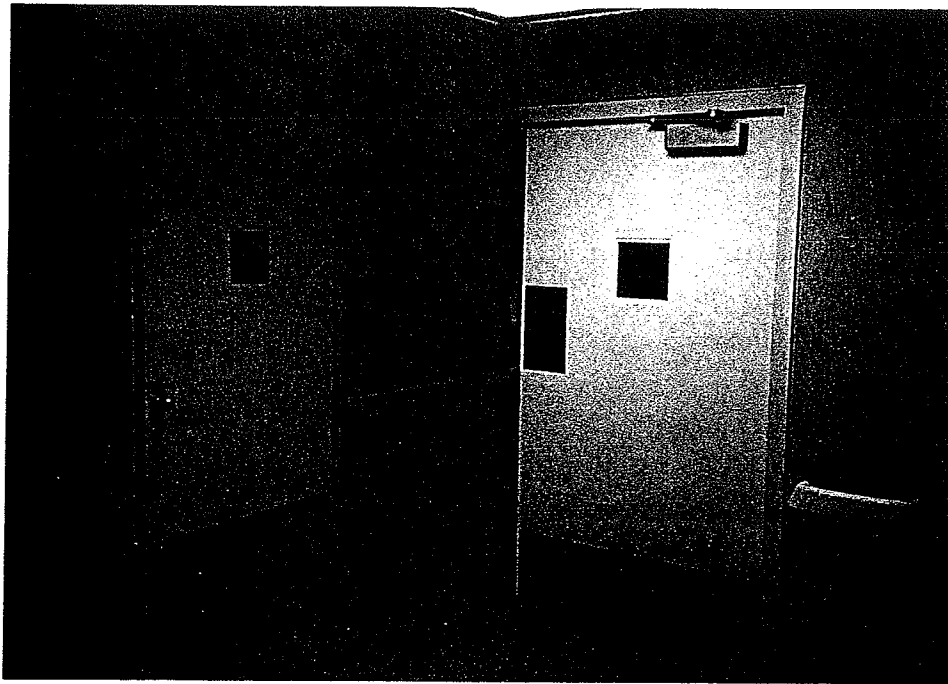
HOMOGENEOUS POSITIVE COMPONENTS
PHOTOGRAPHS

Typical Window Frame
Positive: Stools, Casings, Stops, Mullions & Headers

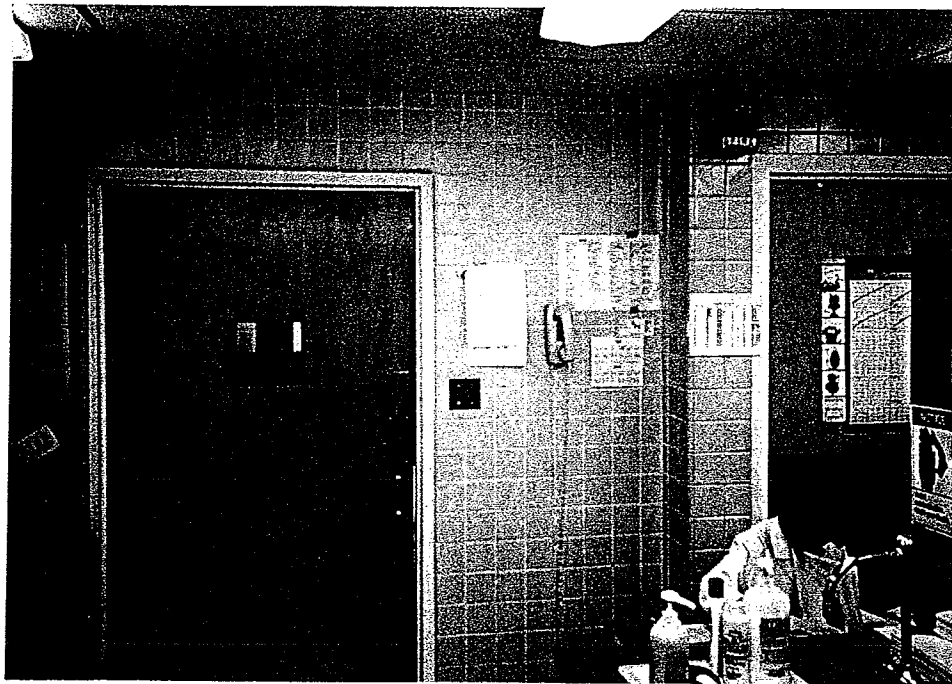


HOMOGENEOUS POSITIVE COMPONENTS
PHOTOGRAPHS

Typical Corridor
Positive: Door Sides A & B

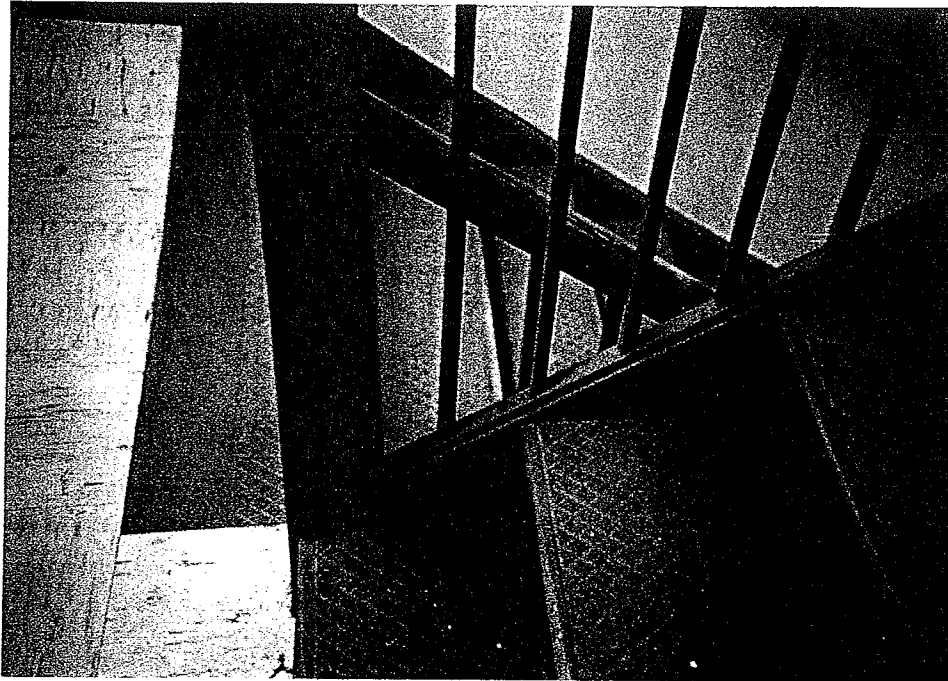


Typical Lab Area
Positive: Tile Walls

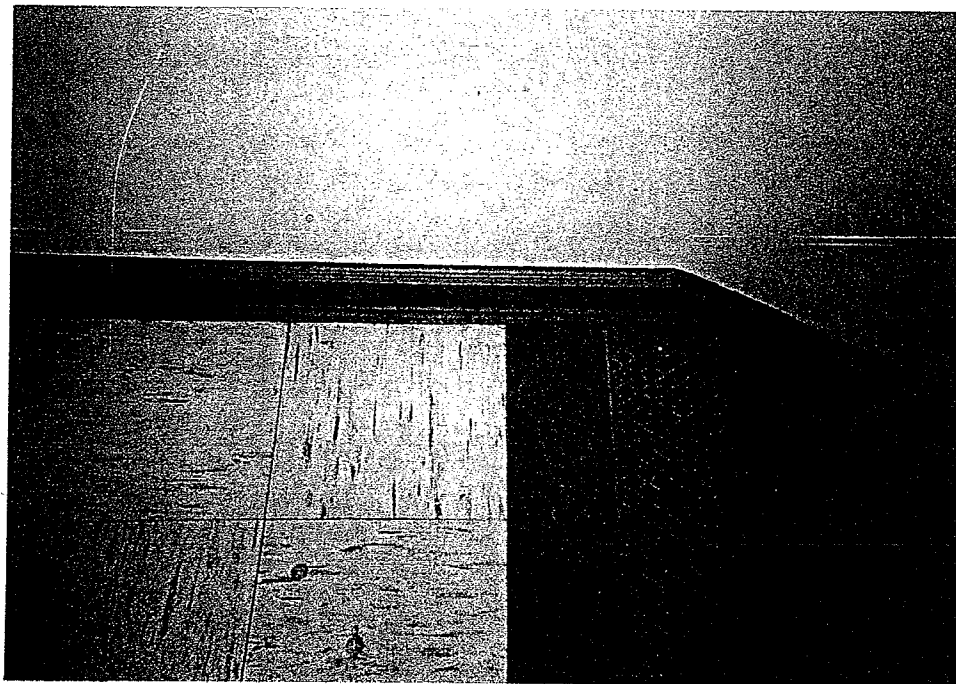


HOMOGENEOUS POSITIVE COMPONENTS
PHOTOGRAPHS

Typical Stairwell
Positive: Newal Post, Baluster, Stringer

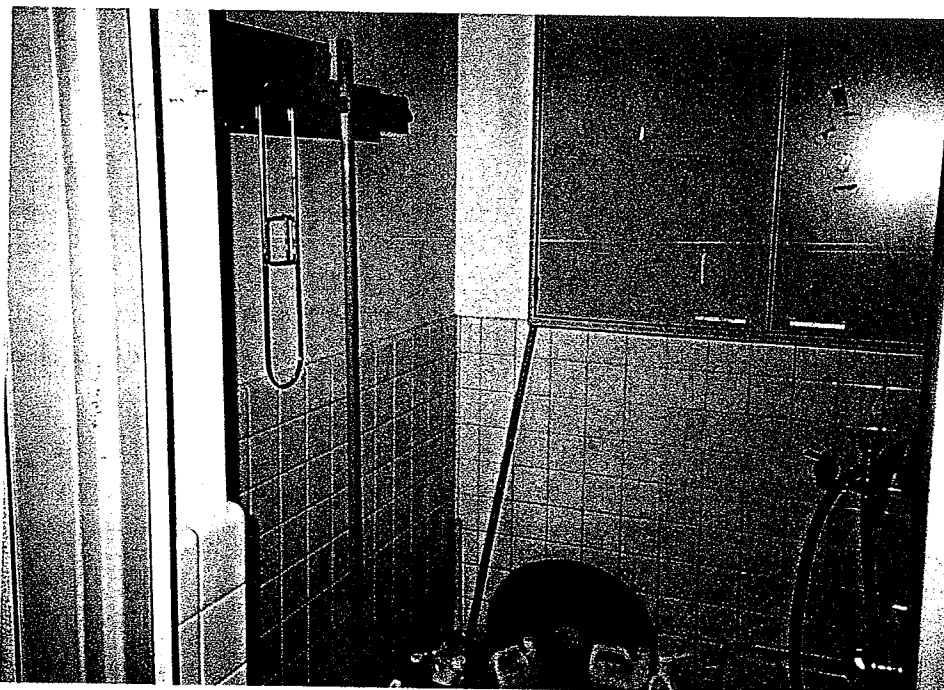


Typical Stairwell Baseboard
Positive: Baseboard



HOMOGENEOUS POSITIVE COMPONENTS
PHOTOGRAPHS

Typical House Keeping Closet
Positive: Tile



Typical House Keeping Closet
Positive: Wood Hanger Bracket

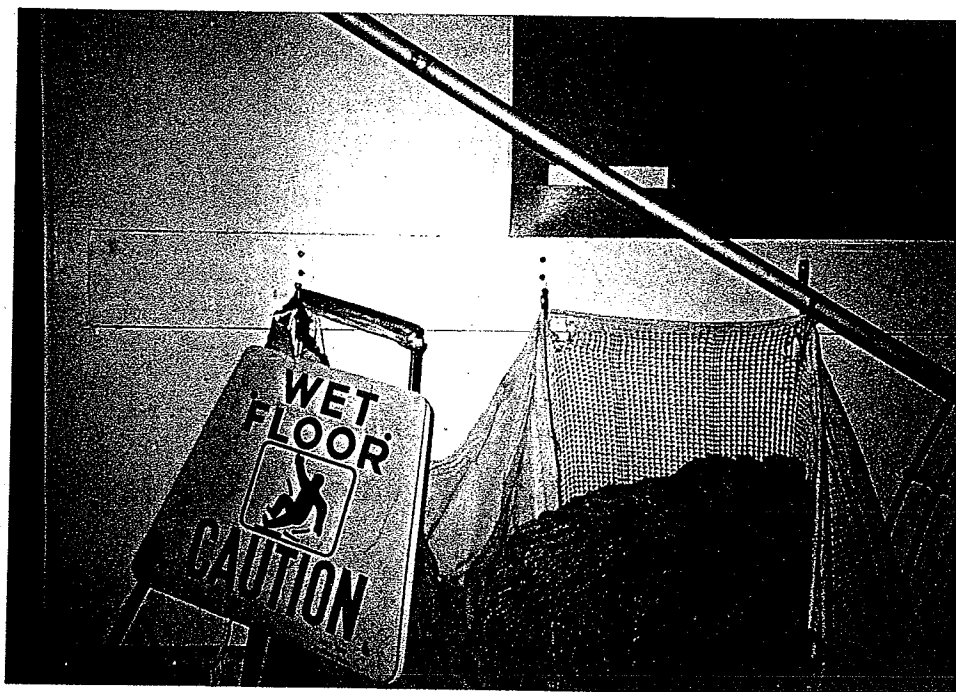


FIGURE NO. 3

DURATION OF TEST, LEAD CONCENTRATION, AND SENSITIVITY OF THE XL

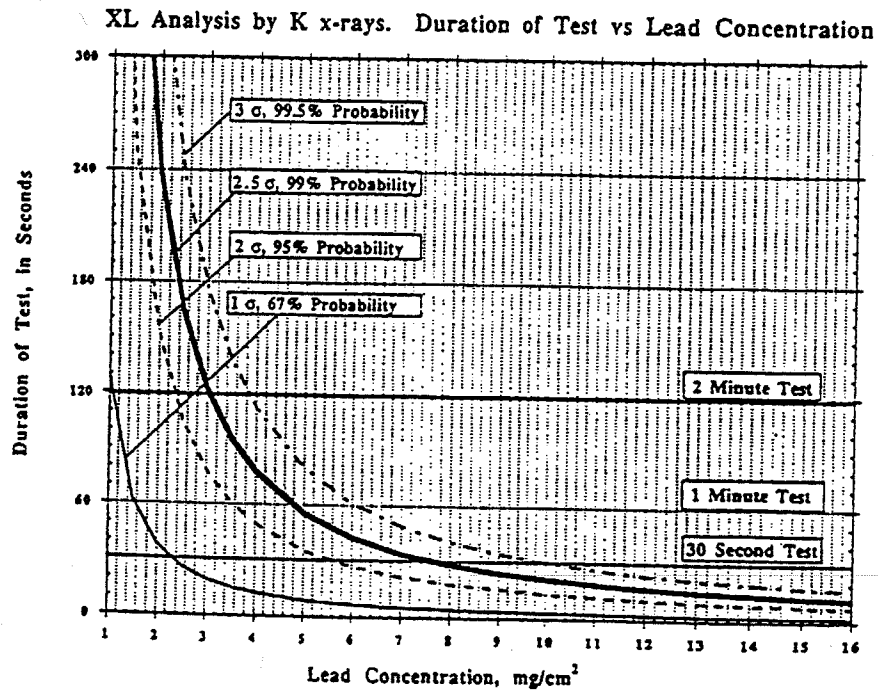
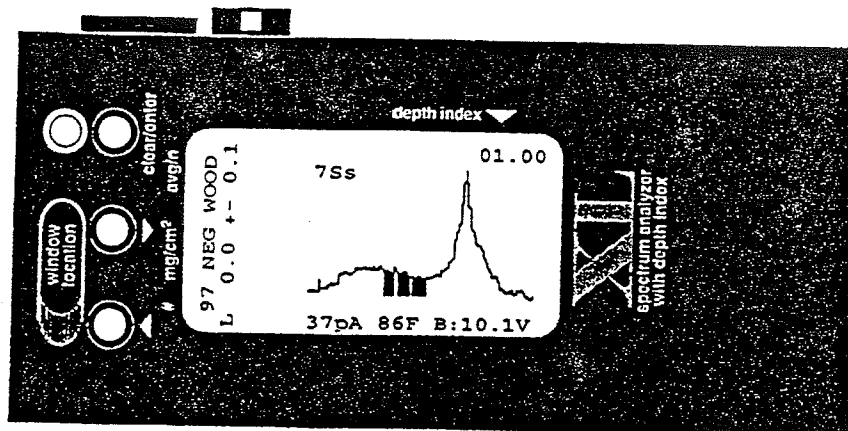
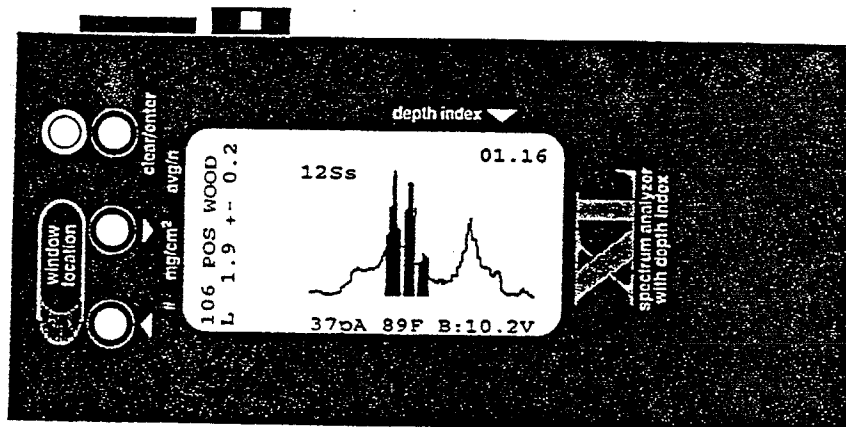


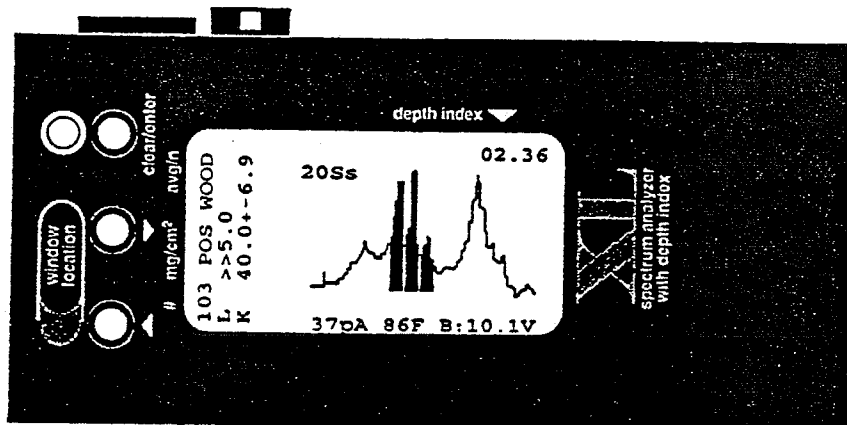
FIGURE NO. 4
SPECTRUM EXAMPLES



1. NO LEAD



2. LEAD ON THE SURFACE
(The alpha peak is highest)



3. LEAD BURIED
(The beta peak is higher than the alpha peak)

5.1 XRF Data and L-Spectrum Interpretation Niton XL 309 L X-Ray

The Niton XL has a specific protocol when interpreting the results of the assay information during the assay procedure. The following details the procedure for interpreting the results as well as identifying the data as positive, negative or inconclusive.

1. The lead concentration is less than 1 mg/cm².

There is no spectrum peak at 12.6 keV and the paint is not thick enough to have hidden the presence of 1 mg/cm² of lead. The figure on the L-line (including the statistical variation) is less than 1.0, for example

L 0.0 +/- 0.1

2. The lead concentration exceeds 1 mg/cm².

a. If there is a peak at 12.6 keV and a peak at 10.5 keV. The Depth Index is between 1 and 9. The XL calculates the lead concentration and displays the value on line 2. This value (including the statistical variation) exceeds 1.0, for example

L 1.6 +/- 0.2

If the concentration is very great, the figure is prefixed by two greater-than signs (meaning that though the concentration exceeds 5.0, the XL does not determine the exact value), for example

L >>5.0 +/- 0.2

b. If there is a peak at 12.6 keV but no peak at 10.5 keV. The Depth Index exceeds 8. The XL is able to unambiguously unravel the spectrum and calculate the lower limit of lead concentration, which is out of compliance, but it cannot give a quantitative value for the concentration. Verify using the K x-ray results. The figure on the L-line which exceeds 1.0 (including the statistical variation) is prefixed by a greater-than sign, for example

L >2.4 +/- ***

3. Lead is present but the XL cannot estimate its strength.

There is a peak at 12.6 keV but no peak or too weak a peak at 10.5 keV. The Depth Index exceeds 8. The spectrum cannot be unraveled. The XL cannot put a quantitative limit on the lead concentration. Use the K x-ray method.

4. Lead may be present.

The 12.6 keV peak is not evident. The spectrum indicates the possibility that the paint is so thick as to mask lead if it were present. Use the K x-ray method.

Buried Lead

Even at a Depth Index of 10 or more, the XL may still measure, with 95% confidence, that the lead concentration is out of compliance. That is, the XL may be unable to tell whether the lead concentration is 2 mg/cm² or 10 mg/cm², but it will know that the lead concentration exceeds 1 mg/cm². It may read

L >2.4 +/- *** if so, we know the lead concentration exceeds 2.4 mg/cm².

The presence of an L beta line at 12.6 keV, that is, a sharp peak centered in the middle black band is a certain indicator that lead is present. Bromine, rarely used in paint but possibly present in the substrate has a broader peak at 11.9 keV and no peak at 10.5 keV. If that sharp beta peak is present, you know you have lead. If the 10.6 keV peak is not observed or is very weak, you know that the lead is deeply buried. The Depth Index will be high, up to 10. Even without the 10.5 keV peak, the 12.6 keV peak may be strong enough for the XL to compute that the lead level is far out of compliance. In that case, the screen will prefix the reading with a single greater-than sign (>). For example, if the 12.6 keV is present but the XL cannot judge how much greater the lead concentration is than 1, line 2 on the screen will read:

L >1.0 +/- ***

This sign means the Depth Index is greater than 8. In either case you should continue the test, using K x-ray method.

K X-Ray

A K x-ray measurement is taken whenever the shutter is open. That is, the K x-ray and L x-ray measurements are concurrent. Here is how the K x-ray analysis works.

In addition to its principal radiations of 22.1 and 25.0 keV, cadmium-109 emits a small amount of gamma radiation at 88.0 keV that can fluoresce K x-rays of lead. The dominant K x-ray energies are at 72.8 keV (K alpha 2) and at 75.0 keV (K alpha 1). Weaker K x-rays from lead occur at 85.0 keV and 87.4 keV (the K beta lines).

The K measurement is independent of the thickness of the paint layer (K x-rays are very penetrating) and can quantify higher levels of lead concentration. The K measurement is susceptible to substrate effect, and usually requires long measurement times (several minutes) to achieve precise and reliable results.

Use the K measurements when the L measurement is inconclusive or uncertain, as indicated by:

1. A high Depth Index (L measurement is preceded by the > sign) --especially if the L reading is low.
2. Large peaks near lead in the L spectrum, such as the zinc peak. These can hide lead.
3. Evidence of elements such as arsenic (which may be found in pressure treated wood) or bromine (which may be found in architectural plastics) in paint or substrate. Such elements directly interfere with lead peaks in the L spectrum.
4. Incorrect substrate identification, such as "NonWood" when you know the substrate is actually wood. This is an indicator of very thick or shielding paint. (The paint shields the wood-scattered Compton x-rays, greatly reducing the Compton count rate.)
5. Very thick paint in a house built before 1957. Very thick paint can mask buried lead from L x-rays.

You may also use K x-rays to quantify lead that is greater than 5.0 mg/cm², the upper limit of L measurement. Use of the K measurement extends the range of the XL to 100 mg/cm² of lead.

Although the K measurement takes place whenever you make a measurement, no results are displayed for the first 20 seconds of the measurement. If a high concentration of lead is detected using K x-rays (>2.5 mg/cm²), POS will be displayed after 20 seconds. A lesser concentration will not be declared POS before 2 minutes of testing.

The reading is periodically updated as long as the shutter remains open. The longer the measurement continues, the higher the precision of the result.

Sensitivity of the XL and Precision of A Measurement

In addition, the longer the measurement continues, the greater the sensitivity to lead paint.

- Thus, in 20 seconds of measurement, an XL using K x-rays is sensitive to 7.0 mg/cm^2 at 95% confidence level (2 standard deviations). This means that if the actual concentration of lead in the paint is 7.0 , 95 times out of 100 the XL will tell us after 20 seconds that this sample is above the action level of 1.0 mg/cm^2 .
- In 60 seconds, the XL is sensitive to 3.5 mg/cm^2 .
- In 2 minutes, the XL is sensitive to 2.0 mg/cm^2 .
- In 5 minutes, the XL is sensitive to 1.4 mg/cm^2 .

A graph of the sensitivity of the K x-ray measurement, as a function of time, is shown below in figure 1.0 for four confidence levels.

The lowest curve (shortest time) is for 67% confidence. In this case, about 2 in 3 of your measurements will be above the action level.

The middle curve is for 95% confidence. You can expect that 19 measurements in 20 will be above the action level.

The top curve is for 99.7% confidence: 997 measurements in a thousand will be above the action level.

These results are for 10 mCi source at full strength. After 15 months, when the source is at half-strength, it will take twice as long to achieve the same results. **The optional 40 mCi source improves reading speed by a factor of 4, so it will take only one quarter the time to achieve the same result.**

The third line of the XL display gives the K shell result, with 2.0 standard deviation (95% confidence level). This expresses the precision or uncertainty of the measurement (not the sensitivity of the instrument). Two examples will help explain the differences.

1. You are about to make a 2-minute test. If you follow the horizontal "2 Minute Test" line of Figure 1.0 over until it meets the 1 σ curve (the solid line curve at the bottom), then you see that you have a 1 standard deviation probability (2 out of 3 chances) of being able to find any concentration of lead greater than 1 mg/cm^2 . You can be 95% certain that if the actual concentration is 2.5 mg/cm^2 or higher, your test will show a POS result.
2. You have made a 2-minute test. The third line reads:

K 10.6 +/- 5.0

This means that you know (with 95% confidence) that the lead concentration is between 5.6 and 16.6 mg/cm^2 .

We give the 2.0 standard deviation uncertainty. In the example immediately above, 10.6 ± 5.0 , 5 is the 2.0 standard deviation precision. Thus, the one standard deviation (67% probability) for that measurement is 2.5 ($=5/2$). And, the 2.5 standard deviation (99% probability) for that measurement is 6.25 ($=5 \times 2.5/2$).

If you quote the result to 1 standard deviation, that is, $10.6 \pm 2.5 \text{ mg/cm}^2$, you are in effect saying that if you make three measurements at the same spot, two of the measurements will fall between 8.1 mg/cm^2 and 13.1 mg/cm^2 and one measurement will fall outside that range.

6.0 Calibrations

Calibration checks were completed as required by the manufacturer and HUD Protocol. These checks were run at the beginning of testing, during testing on four (4) hour intervals and at the end of the testing day. All calibrations met tolerance limits set by the performance characteristic sheets. Calibration data can be found in Appendix D.

7.0 Quality Control Data

At the end of the data collection, a total of nine (9) rooms were randomly selected to be retested. Each room retest is compared to the original test data collected previously. A retest Tolerance Limit is calculated by utilizing the formula provided in the Performance Characteristics Sheet (PCS) for the Niton XL 309, page 7 and 8. The following chart illustrates the Retest Tolerance Limit and its final confirmation of data Quality. All data collected met the tolerance limit standard set by the PCS.

XRF DATA EVALUATION CHART

Floor / Room	Diff. Overall Averages	Retest Tolerance Limit	Difference / (Pass / Retest)
Basement (B-11)	0.06	0.1156	Difference < / Pass
First (B-163)	0.001429	.295038	Difference < / Pass
Second (A-227)	0.0049	.294533	Difference < / Pass
Third (B-316)	0.009	1.032	Difference < / Pass
Fourth (A-410)	0.0575	0.57525	Difference < / Pass
Fifth (A-505)	0.0 211	0.2991	Difference < / Pass
Six (A-638)	0.0094	0.6683	Difference < / Pass
Ninth (A-931)	0.3761	0.849	Difference < / Pass

The quality control data or room retest data is found in Appendix E.

8.0 Radiation Monitoring of Operator

Radiation Monitoring of the operator was performed from September through December in order to document that the Niton XL 309 XRF unit was not causing radioactive exposure to the operator during the operation of the unit. Monitoring assures that equipment is operating safely and that proper equipment use is followed. The whole body exposure report can be found in Appendix F. The report indicates no exposure to the operator occurred during the use of the unit during first the four months of use.

SECTION II

Room B-331

Site: V.A.M.C. Date: 01/23/97

Ranges (NEG<INC<POS): 0.0<1.00<1.00 Times: minL = 5 Ssec minK = 60 Ssec

XLNo	Flr	Room	Side	Structure	Feature	Cond.	Substr.	P.C. Sample	PbL(mg/cm ²)	RES	PbK	DI	Ssec	Final Result
159	3	Room B-331		Wall-A	Wall-Uptr		Plaster		0.11 ± 0.05	NEG	-1.6 ± 3.8	1.3	22	—
160	3	Room B-331		Wall-D	Middle Wall		Plaster		0.12 ± 0.05	NEG	-2.1 ± 3.5	1.4	22	—
161	3	Room B-331		Wall-D	Wall-Lwr		Plaster		0.11 ± 0.05	NEG	-0.1 ± 6.1	1.3	22	—
162	3	Room B-331	A	Door	Door		Wood		0.00 ± 0.00	NEG	-1.1 ± 2.5	1.0	21	—
163	3	Room B-331	B	Door	Door		Wood		0.01 ± 0.09	NEG	-1.3 ± 2.4	1.0	21	—
164	3	Room B-331	C	Door	Door		Wood		0.03 ± 0.08	NEG	-0.7 ± 3.3	1.3	21	—
165	3	Room B-331	A	Door	Jamb-Lft		Metal		0.14 ± 0.06	NEG	0.7 ± 5.9	1.6	22	—
166	3	Room B-331	B	Door	Casing-Lft		Metal		0.15 ± 0.09	NEG	-1.0 ± 3.3	2.5	22	—
167	3	Room B-331	B	Door	Header		Metal		0.13 ± 0.07	NEG	-0.8 ± 3.4	2.0	22	—
168	3	Room B-331		Ceiling			Plaster		0.08 ± 0.05	NEG	-0.9 ± 4.2	1.4	22	—
169	3	Room B-331		Floor			Concrete		0.05 ± 0.05	NEG	-1.5 ± 2.8	1.5	23	—
170	3	Room B-331		Floor			Concrete		0.09 ± 0.09	NEG	-1.8 ± 3.1	2.4	22	—

Room B-322

Site: V.A.M.C. Date: 01/24/97

Ranges (NEG<INC<POS): 0.0<1.00<1.00 Times: minL = 5 Ssec minK = 60 Ssec

XLNo	Fir	Room	Side	Structure	Feature	Cond.	Substr.	P.C. Sample	PbL(mg/cm ²)	RES	PbK	DI	Ssec	Final Result
58	3	Room B-322		Wall-A	Wall-Upr		Plaster		0.29 ± 0.11	NEG	-2.3 ± 3.2	2.3	22	—
59	3	Room B-322		Wall-D	Middle Wall		Plaster		0.28 ± 0.10	NEG	-1.7 ± 3.0	2.1	22	—
60	3	Room B-322		Wall-C	Wall-Lwr		Plaster		0.26 ± 0.08	NEG	-1.7 ± 3.5	1.8	22	—
61	3	Room B-322		Floor			Concrete		0.11 ± 0.05	NEG	-0.2 ± 5.7	1.5	27	—
62	3	Room B-322		Floor			Concrete		0.10 ± 0.05	NEG	-1.6 ± 2.9	1.5	22	—
63	3	Room B-322		Door	Door		Wood		0.01 ± 0.07	NEG	-0.6 ± 1.8	1.0	22	—
64	3	Room B-322	A	Door	Door		Wood		0.00 ± 0.00	NEG	-0.3 ± 2.1	1.0	22	—
65	3	Room B-322	B	Door	Casing-Lft		Metal		0.11 ± 0.04	NEG	0.6 ± 6.4	1.3	27	—
66	3	Room B-322	A	Door	Casing-Lft		Metal		0.16 ± 0.13	NEG	0.3 ± 5.9	3.3	23	—
67	3	Room B-322	B	Door	Header		Metal		0.14 ± 0.04	NEG	-0.7 ± 4.7	1.2	24	—
68	3	Room B-322		Ceiling	Diffuser*		Metal		0.23 ± 0.08	NEG	-0.9 ± 3.6	2.0	22	—
69	3	Room B-322		Ceiling	Pan*		Plaster		0.21 ± 0.09	NEG	-1.3 ± 2.6	2.2	22	—
70	3	Room B-322		Wall-A	Wall Rgstr		Metal		0.01 ± 0.00	NEG	-0.2 ± 3.6	1.0	22	—
71	3	Room B-322		Wall-A	Wall Rgstr		Metal		0.01 ± 0.00	NEG	-0.1 ± 4.3	1.0	22	—

Room B-321

Site: V.A.M.C. Date: 01/24/97

Ranges (NEG<INC<POS): 0.0<1.00<1.00 Times: minL = 5 Ssec minK = 60 Ssec

XLNo	Fir	Room	Side	Structure	Feature	Cond.	Substr.	P.C. Sample	PbL(mg/cm ²)	RES	PbK	DI	Ssec	Final Result
42	3	Room B-321		Wall-A	Wall-Up		Plaster		0.11 ± 0.08	NEG	-1.1 ± 3.8	2.1	22	—
43	3	Room B-321		Wall-D	Middle Wall		Plaster		0.18 ± 0.10	NEG	-3.0 ± 3.1	2.5	23	—
45	3	Room B-321		Wall-A	Wall-Lwr		Plaster		0.11 ± 0.07	NEG	-2.7 ± 3.1	1.9	22	—
46	3	Room B-321		Floor			Concrete		0.05 ± 0.04	NEG	-0.6 ± 5.0	1.3	22	—
47	3	Room B-321		Floor			Concrete		0.17 ± 0.10	NEG	-2.0 ± 3.0	2.4	22	—
48	3	Room B-321		Cabinet	Shelf		Metal		0.09 ± 0.08	NEG	-1.8 ± 3.3	2.4	22	—
49	3	Room B-321		Bookcase	Shelf		Metal		0.06 ± 0.04	NEG	0.1 ± 5.3	1.5	22	—
50	3	Room B-321	A	Door	Door		Wood		0.00 ± 0.00	NEG	-0.8 ± 2.1	1.0	23	—
51	3	Room B-321	B	Door	Door		Wood		0.00 ± 0.01	NEG	-0.6 ± 3.7	1.0	22	—
52	3	Room B-321	A	Door	Casing-Lft		Metal		0.15 ± 0.08	NEG	-0.5 ± 4.9	2.2	22	—
53	3	Room B-321	B	Door	Casing-Lft		Metal		0.12 ± 0.08	NEG	-1.2 ± 2.6	2.3	22	—
54	3	Room B-321	B	Door	Header		Metal		0.10 ± 0.06	NEG	-1.3 ± 3.4	1.8	22	—
56	3	Room B-321		Ceiling	Diffuser*		Metal		0.13 ± 0.08	NEG	0.2 ± 6.0	2.2	22	—
57	3	Room B-321		Ceiling			Plaster		0.12 ± 0.07	NEG	-0.7 ± 4.4	1.7	22	—

Room B-320

Site: V.A.M.C. Date: 01/23/97

Ranges (NEG<INC<POS): 0.0<1.00<1.00 Times: minL = 5 Ssec minK = 60 Ssec

XLNo	Fir	Room	Side	Structure	Feature	Cond.	Substr.	P.C. Sample	PbL(mg/cm ²)	RES	PbK	DI	Ssec	Final Result
308	3	Room B-320		Wall-A	Wall-Uptr		Tile		0.20 ± 0.16	NEG	-2.4 ± 3.9	3.0	20	—
309	3	Room B-320		Wall-C	Middle Wall		Tile		0.26 ± 0.19	NEG	-1.5 ± 3.7	3.6	22	—
310	3	Room B-320		Wall-D	Wall-Lwr		Tile		0.45 ± 0.31	NEG	-2.3 ± 3.4	5.2	22	—
311	3	Room B-320		Wall-D	Rad. Cover*		Metal		0.14 ± 0.15	NEG	-0.1 ± 5.3	3.7	22	—
312	3	Room B-320		Wall-D	Rad. Cover*		Metal		0.15 ± 0.12	NEG	-2.7 ± 3.2	3.1	22	—
313	3	Room B-320		Window-D	Casing*-Lft		Wood		2.19 ± 1.03	POS	-1.1 ± 3.4	7.1	11	POS
314	3	Room B-320		Door-1	Door		Metal		0.86 ± 0.09	NEG	-0.3 ± 4.6	1.0	22	—
315	3	Room B-320	C	Door-1	Door		Metal		0.77 ± 0.08	NEG	0.7 ± 5.9	1.0	24	—
316	3	Room B-320	C	Door-1	Door		Metal		0.52 ± 0.01	NEG	2.6 ± 8.8	1.0	33	—
317	3	Room B-320	A	Door-1	Door		Metal		0.68 ± 0.08	NEG	-0.7 ± 4.3	1.0	22	—
318	3	Room B-320	B	Door-1	Casing-Rht		Metal		0.01 ± 0.05	NEG	-0.9 ± 2.7	1.2	22	—
319	3	Room B-320	B	Door-1	Casing-Rht		Metal		0.01 ± 0.02	NEG	-0.7 ± 4.3	1.0	22	—
320	3	Room B-320	B	Door-1	Header		Metal		0.00 ± 0.00	NEG	-0.3 ± 5.0	1.0	22	—
321	3	Room B-320		Ceiling	Pipes		Metal		0.01 ± 0.04	NEG	-2.5 ± 3.1	1.2	22	—
322	3	Room B-320		Ceiling	Pipes		Metal		0.01 ± 0.03	NEG	0.6 ± 5.9	1.1	26	—
323	3	Room B-320		Wall	Diffuser*		Metal		0.13 ± 0.16	NEG	-0.1 ± 6.1	3.7	22	—
324	3	Room B-320		Wall	Diffuser*		Metal		0.06 ± 0.07	NEG	-1.2 ± 3.5	2.1	22	—
325	3	Room B-320		Ceiling	Diffuser*		Metal		0.01 ± 0.07	NEG	-1.7 ± 2.6	1.3	23	—
326	3	Room B-320		Ceiling	Panel*		Metal		0.18 ± 0.24	NEG	0.4 ± 6.0	7.4	25	—
327	3	Room B-320		Ceiling	Panel*		Plaster		0.06 ± 0.07	NEG	-2.6 ± 3.0	2.0	24	—
328	3	Room B-320		Wall-A	Wall-Uptr		Plaster		0.04 ± 0.06	NEG	-1.7 ± 2.6	1.6	22	—
329	3	Room B-320		Wall-B	Middle Wall		Plaster		0.08 ± 0.08	NEG	-1.6 ± 2.8	2.1	22	—
330	3	Room B-320		Wall-C	Wall-Lwr		Plaster		0.09 ± 0.10	NEG	-0.7 ± 3.5	2.5	22	—
331	3	Room B-320	A	Door-1	Door		Wood		0.01 ± 0.03	NEG	-1.7 ± 2.7	1.0	22	—
332	3	Room B-320	B	Door-2	Door		Wood		0.00 ± 0.00	NEG	-1.2 ± 2.5	1.0	22	—
333	3	Room B-320	A	Door-2	Casing-Lft		Metal		0.11 ± 0.15	NEG	-1.3 ± 2.7	3.6	22	—
334	3	Room B-320	A	Door-1	Casing-Lft		Metal		0.15 ± 0.11	NEG	-0.8 ± 4.6	2.8	22	—
335	3	Room B-320	B	Door-1	Header		Metal		0.10 ± 0.07	NEG	-0.8 ± 4.0	2.1	23	—
336	3	Room B-320		Window-B	Casing*-Lft		Metal		0.25 ± 0.35	NEG	0.3 ± 5.7	7.0	25	—
337	3	Room B-320		Window-C	Stool*		Metal		0.03 ± 0.07	NEG	-0.7 ± 4.3	1.9	22	—
338	3	Room B-320		Ceiling	Wall-Uptr		Metal		0.05 ± 0.09	NEG	-0.8 ± 2.7	7.4	22	—
339	3	Room B-320		Wall-A	Middle Wall		Tile		0.33 ± 0.30	NEG	-1.2 ± 5.3	4.9	20	—
340	3	Room B-320		Wall-B	Wall-Lwr		Tile		0.30 ± 0.24	NEG	-2.0 ± 3.2	4.2	20	—
341	3	Room B-320		Wall-C	Rad. Cover*		Plaster		0.10 ± 0.17	NEG	-1.2 ± 3.9	3.6	22	—
342	3	Room B-320		Wall-C	Rad. Cover*		Metal		0.07 ± 0.07	NEG	-1.8 ± 2.8	2.0	22	—
343	3	Room B-320		Window-C	Apron*		Wood		2.51 ± ***	...	0.5 ± 10.0	10.0	8	POS
344	3	Room B-320		Window-C	Blind*		Metal		0.00 ± 0.03	NEG	-0.9 ± 4.2	1.0	8	—
345	3	Room B-320		Window-C	Blind*		Metal		0.00 ± 0.09	NEG	-0.7 ± 1.9	1.0	22	—
346	3	Room B-320	A	Door	Door		Wood		0.00 ± 0.00	NEG	-0.7 ± 2.8	1.0	21	—
347	3	Room B-320	B	Door	Door		Wood		0.01 ± 0.18	NEG	-0.7 ± 1.9	1.2	22	—
348	3	Room B-320	A	Door	Casing-Rht		Metal		0.04 ± 0.07	NEG	0.7 ± 7.0	2.0	22	—
349	3	Room B-320	B	Door	Casing-Rht		Metal		0.02 ± 0.03	NEG	-1.1 ± 2.6	1.1	22	—
350	3	Room B-320	B	Door	Header		Metal		0.05 ± 0.06	NEG	-0.5 ± 4.4	1.9	22	—

Room B-318

Site: V.A.M.C. Date: 01/23/97

Ranges (NEG<INC<POS): 0.0<1.00<1.00 Times: minL = 5 Ssec minK = 60 Ssec

XLNo	Fir	Room	Side	Structure	Feature	Cond.	Substr.	P.C. Sample	PbL(mg/cm ²)	RES	PbK	DI	Ssec	Final Result
278	3	Room B-318		Wall-A	Wall-Uptr		Tile		0.17 ± 0.13	NEG	-2.4 ± 3.4	2.5	22	—
279	3	Room B-318		Wall-C	Middle Wall		Tile		0.30 ± 0.22	NEG	-3.1 ± 3.3	4.0	22	—
280	3	Room B-318		Wall-D	Wall-Lwr		Tile		0.19 ± 0.14	NEG	-1.3 ± 4.2	2.9	22	—
281	3	Room B-318		Wall-B	Rad. Cover*		Metal		0.25 ± 0.09	NEG	1.2 ± 5.1	3.9	61	—
282	3	Room B-318		Wall-B	Rad. Cover*		Metal		0.12 ± 0.08	NEG	-0.3 ± 4.2	2.4	25	—
283	3	Room B-318		Wall-B	Rad. Cover*		Metal		0.28 ± 0.20	NEG	-0.9 ± 3.4	4.6	22	—
284	3	Room B-318		Window-B	Casing*-Rht		Wood		2.49 ± 1.00	POS	1.0 ± 10.1	5.4	9	POS
285	3	Room B-318	A	Door-1	Door		Wood		0.00 ± 0.00	NEG	-1.1 ± 2.3	1.0	21	—
286	3	Room B-318	B	Door-1	Door		Wood		0.02 ± -0.01	NEG	-1.6 ± 2.5	4.6	22	—
287	3	Room B-318	A	Door-1	Jamb-Rht		Metal		0.03 ± 0.11	NEG	0.2 ± 5.2	2.5	22	—
288	3	Room B-318	B	Door-1	Casing-Rht		Metal		0.03 ± 0.05	NEG	0.3 ± 6.3	1.5	22	—
289	3	Room B-318	C	Door-2	Door		Metal		0.10 ± 0.05	NEG	-0.2 ± 4.4	1.6	22	—
290	3	Room B-318	C	Door-2	Door		Metal		0.08 ± 0.04	NEG	-1.0 ± 3.1	1.2	24	—
291	3	Room B-318		Ceiling	Diffuser*		Metal		0.05 ± 0.11	NEG	-0.9 ± 3.6	2.6	22	—
292	3	Room B-318		Ceiling	Diffuser*		Plaster		0.07 ± 0.13	NEG	-3.3 ± 3.6	3.0	22	—
293	3	Room B-318		Ceiling	Diffuser*		Metal		0.01 ± 0.04	NEG	1.1 ± 8.2	1.1	21	—
294	3	Room B-318		Ceiling	Diffuser*		Metal		0.01 ± 0.02	NEG	1.5 ± 6.5	1.1	41	—
295	3	Room B-318		Wall-A	Wall-Uptr		Plaster		0.06 ± 0.06	NEG	-2.6 ± 3.2	1.7	22	—
296	3	Room B-318		Wall-B	Middle Wall		Plaster		0.09 ± 0.08	NEG	-0.2 ± 5.4	2.2	22	—
297	3	Room B-318	A	Door	Door		Wood		0.00 ± 0.11	NEG	-0.6 ± 3.3	1.0	21	—
298	3	Room B-318	B	Door	Door		Wood		0.00 ± 0.09	NEG	-2.2 ± 2.9	1.0	21	—
299	3	Room B-318	B	Door	Casing-Lft		Metal		0.08 ± 0.10	NEG	-1.0 ± 4.5	2.1	13	—
300	3	Room B-318	B	Door	Casing-Rht		Metal		0.09 ± 0.06	NEG	-0.5 ± 4.9	1.8	22	—
301	3	Room B-318	B	Door	Header		Metal		0.08 ± 0.06	NEG	-1.2 ± 2.6	2.0	22	—
302	3	Room B-318	B	Floor			Concrete		0.32 ± 0.11	NEG	-0.5 ± 5.9	2.3	22	—
303	3	Room B-318		Floor			Concrete		0.20 ± 0.07	NEG	-2.5 ± 3.5	1.7	23	—
304	3	Room B-318		Wall-B	Diffuser*		Metal		0.04 ± 0.12	NEG	-0.5 ± 5.6	1.9	10	—
305	3	Room B-318		Wall-B	Diffuser*		Metal		0.06 ± 0.10	NEG	-1.4 ± 2.7	2.7	22	—
306	3	Room B-318		Ceiling	Panel*		Metal		0.08 ± 0.10	NEG	-1.4 ± 3.3	2.7	22	—
307	3	Room B-318		Ceiling			Plaster		0.02 ± 0.10	NEG	-1.1 ± 2.8	1.9	22	—

Room B-316

Site: V.A.M.C. Date: 01/24/97

Ranges (NEG<INC<POS): 0.0<1.00<1.00 Times: minL = 5 Ssec minK = 60 Ssec

XLNo	Flr	Room	Side	Structure	Feature	Cond.	Substr.	P.C. Sample	PbL(mg/cm ²)	RES	PbK	DI	Ssec	Final Result
22	3	Room B-316		Wall-A	Middle Wall		Plaster		0.14 ± 0.28	NEG	-1.4 ± 2.5	5.8	22	—
23	3	Room B-316		Wall-B	Wall-Up		Plaster		0.13 ± 0.13	NEG	-1.7 ± 2.6	3.1	22	—
24	3	Room B-316		Wall-C	Middle Wall		Plaster		0.01 ± 0.03	NEG	-0.8 ± 2.7	1.0	22	—
25	3	Room B-316		Wall-B	Baseboard		Tile		>>5.0 ± 1.00	POS	14.7 ± 43.3	1.7	6	POS
26	3	Room B-316		Wall-C	Baseboard		Tile		>>5.0 ± 1.00	POS	3.5 ± 23.1	1.9	6	POS
27	3	Room B-316		Wall-A	Baseboard		Tile		>>5.0 ± 1.00	POS	3.3 ± 22.7	1.7	6	POS
28	3	Room B-316		Floor			Tile		0.20 ± 0.29	NEG	-1.2 ± 2.6	5.4	22	—
29	3	Room B-316		Floor			Tile		0.13 ± 0.27	NEG	-1.7 ± 2.7	4.6	22	—
30	3	Room B-316		Wall-2	Middle Wall		Metal		0.48 ± ***	NEG	-0.8 ± 1.3	10.0	60	—
31	3	Room B-316		Wall-2	Middle Wall		Metal		0.05 ± 0.04	NEG	-1.1 ± 2.3	1.3	22	—
32	3	Room B-316		Wall-2	Middle Wall		Metal		0.07 ± 0.06	NEG	0.0 ± 4.7	1.8	22	—
33	3	Room B-316	A	Door	Door		Wood		0.00 ± 0.00	NEG	0.1 ± 4.4	1.0	21	—
34	3	Room B-316	B	Door	Door		Wood		0.00 ± 0.07	NEG	-0.6 ± 1.9	1.0	22	—
35	3	Room B-316	A	Door	Door		Metal		0.00 ± 0.04	NEG	-1.0 ± 2.5	1.0	22	—
36	3	Room B-316	B	Door	Casing-Rht		Metal		0.00 ± 0.00	NEG	-1.8 ± 2.6	1.0	23	—
37	3	Room B-316	B	Door	Header		Metal		0.00 ± 0.01	NEG	-0.8 ± 3.9	1.0	22	—
38	3	Room B-316	B	Door	Header		Metal		0.16 ± 0.20	NEG	-1.6 ± 3.0	4.6	22	—
39	3	Room B-316		Wall-A	Panel*		Metal	(6-3)* <0.01%	0.26 ± ***	...	1.4 ± 6.9	10.0	30	NEG
40	3	Room B-316		Wall-A	Panel*		Metal	(6-3)* <0.01%	0.22 ± ***	INC	-0.4 ± 2.4	10.0	60	NEG
41	3	Room B-316		Ceiling	Par*		Metal		0.03 ± 0.14	NEG	-1.8 ± 2.6	2.6	22	—

Room B-314-a,b

Site: V.A.M.C. Date: 01/23/97

Ranges (NEG<INC<POS): 0.0<1.00<1.00 Times: minL = 5 Ssec minK = 60 Ssec

XLNo	Fir	Room	Side	Structure	Feature	Cond.	Substr.	P.C. Sample	PbL(mg/cm ²)	RES	PbK	DI	Ssec	Final Result
247	3	Room B-314-a,b		Wall-B	Wall-Up		Plaster		0.34 ± ***	NEG	-2.0 ± 1.9	10.0	61	---
248	3	Room B-314-a,b		Wall-C	Middle Wall		Plaster		0.01 ± 0.06	NEG	-1.2 ± 3.7	1.2	22	---
249	3	Room B-314-a,b		Wall-D	Wall-Lwr		Drywall		1.28 ± ***	---	-0.7 ± 3.2	10.0	22	POS
250	3	Room B-314-a,b		Wall-D	Middle Wall		Drywall		2.09 ± ***	---	-3.3 ± 5.8	10.0	9	POS
251	3	Room B-314-a,b		Wall-B	Rad. Cover*		Metal		0.00 ± 0.00	---	0.3 ± 6.3	1.0	22	---
252	3	Room B-314-a,b		Ceiling	DC Grid*		Metal		0.02 ± 0.12	NEG	1.5 ± 6.5	2.6	29	---
253	3	Room B-314-a,b		Ceiling	DC Grid*		Metal		0.00 ± 0.03	NEG	0.7 ± 6.3	1.0	20	---
254	3	Room B-314-a,b		Wall-B	Wall-Up		Drywall		1.41 ± ***	---	-0.2 ± 3.6	10.0	22	POS
255	3	Room B-314-a,b		Wall-B	Wall-Up		Drywall		1.04 ± ***	---	-0.4 ± 2.4	10.0	23	POS
256	3	Room B-314-a,b		Wall-D	Middle Wall		Tile		0.30 ± 0.15	NEG	-2.3 ± 3.2	2.6	22	---
257	3	Room B-314-a,b		Wall-D	Middle Wall		Tile		0.30 ± 0.17	NEG	-2.2 ± 3.9	2.9	20	---
258	3	Room B-314-a,b		Wall-D	Rad. Cover*		Metal		0.06 ± 0.17	NEG	0.8 ± 7.1	3.4	22	---
259	3	Room B-314-a,b		Window-D	Mullion*		Wood		4.19 ± ***	---	2.2 ± 14.8	8.0	8	POS
260	3	Room B-314-a,b		Window-D	Blind*		Metal		0.00 ± 0.01	NEG	-2.7 ± 3.1	1.0	22	---
261	3	Room B-314-a,b		Window-D	Blind*		Metal		0.04 ± 0.10	NEG	-0.7 ± 1.4	5.3	47	---
262	3	Room B-314-a,b		Ceiling	Panel*		Metal		0.00 ± 0.08	NEG	0.9 ± 6.8	1.0	22	---
263	3	Room B-314-a,b		Wall-A	Wall-Up		Plaster		0.09 ± 0.21	NEG	-1.9 ± 2.7	5.7	22	---
264	3	Room B-314-a,b		Wall-B	Middle Wall		Plaster		0.06 ± 0.19	NEG	-2.2 ± 2.7	3.7	24	---
265	3	Room B-314-a,b		Wall-C	Middle Wall		Plaster		0.05 ± 0.11	NEG	-1.6 ± 2.7	2.6	22	---
266	3	Room B-314-a,b		Wall-B	Rad. Cover*		Metal		0.05 ± 0.05	NEG	-0.3 ± 5.0	1.7	22	---
267	3	Room B-314-a,b	A	Door	Door		Wood		0.00 ± 0.10	NEG	-1.2 ± 2.4	1.0	22	---
268	3	Room B-314-a,b	A	Door	Door		Wood		0.00 ± 0.00	NEG	-0.8 ± 2.8	1.0	21	---
269	3	Room B-314-a,b	B	Door	Win. Frame		Metal		0.02 ± 0.01	NEG	-0.2 ± 5.0	1.0	21	---
270	3	Room B-314-a,b	A	Door	Casing-Lft		Metal		0.00 ± 0.03	NEG	-0.6 ± 3.5	1.0	22	---
271	3	Room B-314-a,b	B	Door	Casing-Lft		Metal		0.00 ± 0.01	NEG	0.6 ± 6.4	1.0	22	---
272	3	Room B-314-a,b	B	Door	Header		Metal		0.00 ± 0.10	NEG	0.8 ± 7.1	1.1	22	---
273	3	Room B-314-a,b	A	Door-1	Casing-Rht		Metal		0.02 ± 0.07	NEG	-0.2 ± 5.2	1.7	22	---
274	3	Room B-314-a,b	B	Door-2	Casing-Lft		Metal		0.00 ± 0.03	NEG	-0.6 ± 3.8	1.0	22	---
275	3	Room B-314-a,b	B	Door	Header		Metal		0.00 ± 0.03	NEG	-0.4 ± 4.7	1.0	22	---
276	3	Room B-314-a,b	A	Door-4	Casing-Rht		Metal		0.01 ± 0.04	NEG	-0.5 ± 5.5	1.3	22	---

Room B-314a

Site: V.A.M.C. Date: 01/23/97

Ranges (NEG<INC<POS): 0.0<1.00<1.00 Times: minL = 5 Ssec minK = 60 Ssec

XLNo	Fir	Room	Side	Structure	Feature	Cond.	Substr.	P.C. Sample	PbL(mg/cm ²)	RES	PbK	DI	Ssec	Final Result
182	3	Room B-314a		Wall-A	Wall-Up*		Plaster		0.00 ± 0.00	NEG	-1.1 ± 2.2	1.0	23	—
183	3	Room B-314a		Wall-C	Rad Cover*		Metal		0.19 ± 0.11	NEG	0.1 ± 4.7	2.7	22	—
184	3	Room B-314a	A	Door	Casing-Lft		Metal		0.11 ± ***	...	0.8 ± 4.7	10.0	43	NC
185	3	Room B-314a	A	Door	Casing-Lft		Metal		0.10 ± ***	POS	1.5 ± 5.4	10.0	60	NC
186	3	Room B-314a	B	Door	Casing-Lft		Metal		0.01 ± 0.12	NEG	-0.3 ± 3.4	2.9	22	—
187	3	Room B-314a	B	Door	Header		Metal		0.08 ± ***	...	-0.4 ± 2.5	10.0	58	NC
188	3	Room B-314a	B	Door	Header		Metal		0.15 ± ***	INC	0.6 ± 3.9	10.0	61	—
189	3	Room B-314a		Ceiling	DC Grid*		Metal		0.00 ± 0.08	NEG	-0.3 ± 3.9	1.4	23	—
190	3	Room B-314a		Wall-A	Wall-Up*		Plaster		0.00 ± 0.02	NEG	-0.6 ± 3.1	1.0	23	—
191	3	Room B-314a		Wall-B	Middle Wall		Drywall		0.01 ± 0.03	NEG	-2.4 ± 3.0	1.0	22	—
192	3	Room B-314a		Wall-D	Middle Wall		Drywall		1.50 ± ***	...	-0.9 ± 2.3	10.0	24	BNC
193	3	Room B-314a		Wall-D	Middle Wall		Drywall		1.40 ± ***	...	-0.5 ± 2.7	10.0	24	BNC
194	3	Room B-314a		Wall-D	Middle Wall		Drywall		1.11 ± ***	...	0.4 ± 5.4	10.0	23	BNC
195	3	Room B-314a		Wall-C	Middle Wall		Drywall		1.36 ± ***	...	-1.9 ± 3.0	10.0	21	BNC
196	3	Room B-314a		Wall-C	Wall-Lwr		Tile		1.55 ± ***	...	-2.7 ± 3.7	10.0	20	BNC
197	3	Room B-314a		Wall-C	Wall-Lwr		Tile		1.50 ± ***	...	-1.5 ± 4.4	10.0	20	BNC
198	3	Room B-314a		Ceiling			Drywall		0.02 ± 0.11	NEG	0.3 ± 4.6	3.8	24	—
199	3	Room B-314a		Ceiling			Drywall		0.00 ± 0.12	NEG	0.0 ± 4.2	1.2	22	—
200	3	Room B-314a		Ceiling			Drywall		0.01 ± 0.10	NEG	-1.0 ± 2.4	2.3	22	—
201	3	Room B-314a		Wall			Metal		0.13 ± ***	...	-1.7 ± 2.7	10.0	20	NC
202	3	Room B-314a		Wall	Diffuser*		Metal		0.11 ± ***	...	-1.0 ± 2.1	10.0	27	NC
203	3	Room B-314a		Wall	Diffuser*		Metal		0.06 ± ***	...	0.2 ± 4.1	10.0	40	NC
204	3	Room B-314a		Wall	Diffuser*		Metal		0.10 ± ***	...	-0.6 ± 3.3	10.0	19	NC
206	3	Room B-314a		Wall	Diffuser*		Metal		0.04 ± ***	...	-1.9 ± 3.4	10.0	15	NC
207	3	Room B-314a		Wall	Diffuser*		Metal		0.11 ± ***	...	-0.3 ± 3.9	10.0	27	NC
208	3	Room B-314a		Wall	Diffuser*		Metal		0.09 ± ***	INC	-0.3 ± 2.0	10.0	62	NC
209	3	Room B-314a		Ceiling	Pipes		Metal		0.00 ± 0.02	NEG	0.1 ± 8.1	1.0	11	—
210	3	Room B-314a		Ceiling	Pipes		Metal		0.01 ± 0.01	NEG	0.0 ± 4.5	1.0	21	—
211	3	Room B-314a		Ceiling	Pipes		Metal		0.01 ± 0.03	NEG	-0.5 ± 3.8	1.2	24	—
212	3	Room B-314a		Wall	Diffuser*		Metal		0.10 ± ***	NEG	-0.9 ± 1.5	10.0	60	—
213	3	Room B-314a		Ceiling	DC Grid*		Metal		0.00 ± 0.04	NEG	0.6 ± 5.4	1.0	23	—
214	3	Room B-314a		Ceiling	DC Grid*		Metal		0.00 ± 0.04	NEG	-0.6 ± 3.4	1.0	21	—
215	3	Room B-314a		Door	Door		Metal		0.01 ± 0.07	NEG	-1.1 ± 2.3	1.7	24	—
216	3	Room B-314a	A	Door	Door		Metal		0.00 ± 0.02	NEG	0.5 ± 5.5	1.0	22	—
217	3	Room B-314a	C	Door	Door		Metal		0.00 ± 0.04	NEG	-1.5 ± 2.7	1.0	23	—
218	3	Room B-314a	A	Door	Casing-Rht		Metal		0.15 ± ***	INC	0.7 ± 4.0	10.0	61	NC
219	3	Room B-314a	B	Door	Jamb-Rht		Metal		0.15 ± ***	...	-0.7 ± 3.9	10.0	24	NC
220	3	Room B-314a	B	Door	Jamb-Rht		Metal		0.14 ± ***	...	0.7 ± 6.1	10.0	26	NC
221	3	Room B-314a	B	Door	Header		Metal		0.11 ± ***	...	-0.7 ± 4.7	10.0	22	NC
222	3	Room B-314a	B	Door	Header		Metal		0.08 ± ***	...	-1.0 ± 2.1	10.0	27	NC
223	3	Room B-314a		Wall-B	Panel*		Metal		0.01 ± 0.00	NEG	0.2 ± 4.3	1.0	39	—
224	3	Room B-314a		Wall-B	Panel*		Metal		0.02 ± 0.03	NEG	-0.7 ± 5.2	1.2	21	—

Room B-314a

Site: V.A.M.C. Date: 01/23/97

Ranges (NEG-INC-POS): 0.0-1.00-1.00 Times: minL = 5 Ssec minK = 60 Ssec

XLNo	Fir	Room	Side	Structure	Feature	Cond.	Substr.	P.C. Sample	PbL(mg/cm ²)	RES	PbK	DI	Ssec	Final Result
182	3	Room B-314a		Wall-A	Wall-Upr		Plaster		0.00 ± 0.00	NEG	-1.1 ± 2.2	1.0	23	—
183	3	Room B-314a		Wall-C	Rad. Cover*		Metal		0.19 ± 0.11	NEG	-0.1 ± 4.7	2.7	22	—
184	3	Room B-314a	A	Door	Casing-Lft		Metal	(7-3)* <0.01%	0.11 ± ***	...	0.8 ± 4.7	10.0	43	NEG
185	3	Room B-314a	A	Door	Casing-Lft		Metal	(7-3)* <0.01%	0.10 ± ***	POS	1.5 ± 5.4	10.0	60	NEG
186	3	Room B-314a	B	Door	Casing-Lft		Metal	(7-3)* <0.01%	0.01 ± 0.12	NEG	-0.3 ± 3.4	2.9	22	NEG
187	3	Room B-314a	B	Door	Header		Metal	(7-3)* <0.01%	0.08 ± ***	...	-0.4 ± 2.5	10.0	58	NEG
188	3	Room B-314a	B	Door	Header		Metal	(7-3)* <0.01%	0.15 ± ***	INC	0.6 ± 3.9	10.0	61	NEG
189	3	Room B-314a		Ceiling	DC Grid*		Metal		0.00 ± 0.08	NEG	-0.3 ± 3.9	1.4	23	—
190	3	Room B-314a		Wall-A	Wall-Upr		Plaster		0.00 ± 0.02	NEG	-0.6 ± 3.1	1.0	23	—
191	3	Room B-314a		Wall-B	Middle Wall		Drywall		0.01 ± 0.03	NEG	-2.4 ± 3.0	1.0	22	—
192	3	Room B-314a		Wall-D	Middle Wall		Drywall	(9-3)* <0.01%	1.50 ± ***	...	-0.9 ± 2.3	10.0	24	NC
193	3	Room B-314a		Wall-D	Middle Wall		Drywall	(9-3)* <0.01%	1.40 ± ***	...	-0.5 ± 2.7	10.0	24	NC
194	3	Room B-314a		Wall-D	Middle Wall		Drywall	(9-3)* <0.01%	1.11 ± ***	...	0.4 ± 5.4	10.0	23	NC
195	3	Room B-314a		Wall-C	Middle Wall		Tile	(9-3)* <0.01%	1.36 ± ***	...	-1.9 ± 3.0	10.0	21	NC
196	3	Room B-314a		Wall-C	Wall-Lwr		Tile	(9-3)* <0.01%	1.55 ± ***	...	-2.7 ± 3.7	10.0	20	NC
197	3	Room B-314a		Wall-C	Wall-Lwr		Tile	(9-3)* <0.01%	1.50 ± ***	...	-1.5 ± 4.4	10.0	20	NC
198	3	Room B-314a		Ceiling			Drywall		0.02 ± 0.11	NEG	0.3 ± 4.6	3.8	24	—
199	3	Room B-314a		Ceiling			Drywall		0.00 ± 0.12	NEG	0.0 ± 4.2	1.2	22	—
200	3	Room B-314a		Ceiling			Drywall		0.01 ± 0.10	NEG	-1.0 ± 2.4	2.3	22	—
201	3	Room B-314a		Wall	Diffuser*		Metal	Not Sampled	0.13 ± ***	...	-1.7 ± 2.7	10.0	20	NC
202	3	Room B-314a		Wall	Diffuser*		Metal	Not Sampled	0.11 ± ***	...	-1.0 ± 2.1	10.0	27	NC
203	3	Room B-314a		Wall	Diffuser*		Metal	Not Sampled	0.06 ± ***	...	0.2 ± 4.1	10.0	40	NC
204	3	Room B-314a		Wall	Diffuser*		Metal	Not Sampled	0.10 ± ***	...	-0.6 ± 3.3	10.0	19	NC
206	3	Room B-314a		Wall	Diffuser*		Metal	Not Sampled	0.04 ± ***	...	-1.9 ± 3.4	10.0	15	NC
207	3	Room B-314a		Wall	Diffuser*		Metal	Not Sampled	0.11 ± ***	...	-0.3 ± 3.9	10.0	27	NC
208	3	Room B-314a		Wall	Diffuser*		Metal	Not Sampled	0.09 ± ***	INC	-0.3 ± 2.0	10.0	62	NC
209	3	Room B-314a		Ceiling	Pipes		Metal		0.00 ± 0.02	NEG	0.1 ± 8.1	1.0	11	—
210	3	Room B-314a		Ceiling	Pipes		Metal		0.01 ± 0.01	NEG	0.0 ± 4.5	1.0	21	—
211	3	Room B-314a		Ceiling	Pipes		Metal		0.01 ± 0.03	NEG	-0.5 ± 3.8	1.2	24	—
212	3	Room B-314a		Wall	Diffuser*		Metal		0.10 ± ***	NEG	-0.9 ± 1.5	10.0	60	—
213	3	Room B-314a		Ceiling	DC Grid*		Metal		0.00 ± 0.04	NEG	0.6 ± 5.4	1.0	23	—
214	3	Room B-314a		Ceiling	DC Grid*		Metal		0.00 ± 0.04	NEG	-0.6 ± 3.4	1.0	21	—
215	3	Room B-314a	A	Door	Door		Metal		0.01 ± 0.07	NEG	-1.1 ± 2.3	1.7	24	—
216	3	Room B-314a	A	Door	Door		Metal		0.00 ± 0.02	NEG	0.5 ± 5.5	1.0	22	—
217	3	Room B-314a	C	Door	Door		Metal		0.00 ± 0.04	NEG	-1.5 ± 2.7	1.0	23	—
218	3	Room B-314a	A	Door	Casing-Rht		Metal	(7-3)* <0.01%	0.15 ± ***	INC	0.7 ± 4.0	10.0	61	NEG
219	3	Room B-314a	B	Door	Jamb-Rht		Metal	(7-3)* <0.01%	0.15 ± ***	...	-0.7 ± 3.9	10.0	24	NEG
220	3	Room B-314a	B	Door	Jamb-Rht		Metal	(7-3)* <0.01%	0.14 ± ***	...	0.7 ± 6.1	10.0	26	NEG
221	3	Room B-314a	B	Door	Header		Metal	(7-3)* <0.01%	0.11 ± ***	...	-0.7 ± 4.7	10.0	22	NEG
222	3	Room B-314a	B	Door	Header		Metal	(7-3)* <0.01%	0.08 ± ***	...	-1.0 ± 2.1	10.0	27	NEG
223	3	Room B-314a		Wall-B	Panel*		Metal		0.01 ± 0.00	NEG	0.2 ± 4.3	1.0	39	—
224	3	Room B-314a		Wall-B	Panel*		Metal		0.02 ± 0.03	NEG	-0.7 ± 5.2	1.2	21	—

Room B-309c

Site: V.A.M.C. Date: 01/23/97

Ranges (NEG<INC<POS): 0.0<1.00<1.00 Times: minL = 5 Ssec minK = 60 Ssec

XLNo	Fir	Room	Side	Structure	Feature	Cond.	Substr.	P.C. Sample	PbL(mg/cm ²)	RES	PbK	DI	Ssec	Final Result
147	3	Room B-309c		Wall-A	Wall-Tpr		Tile		0.20 ± 0.16	NI:G	-2.9 ± 3.7	3.0	20	---
148	3	Room B-309c		Wall-B	Wall-Tpr		Tile		0.13 ± 0.08	NI:G	-1.3 ± 4.1	1.8	22	---
149	3	Room B-309c		Wall-B	Middle Wall		Tile		0.20 ± 0.16	NI:G	-2.3 ± 3.4	2.9	20	---
150	3	Room B-309c	A	Door	Door		Wood		0.00 ± 0.05	NI:G	-1.0 ± 2.3	1.0	22	---
151	3	Room B-309c	B	Door	Door		Metal		0.00 ± 0.02	NI:G	-1.5 ± 2.6	1.0	21	---
152	3	Room B-309c	B	Door	Door		Metal		0.03 ± 0.03	NI:G	0.2 ± 4.9	1.1	21	---
153	3	Room B-309c	A	Door	Win. Frame		Metal		0.02 ± 0.00	NI:G	-0.5 ± 3.9	1.0	21	---
154	3	Room B-309c	A	Door	Win. Frame		Metal		0.03 ± 0.04	NI:G	-0.2 ± 5.7	1.5	22	---
155	3	Room B-309c	B	Door	Casing-Lft		Metal		0.02 ± 0.03	NI:G	-0.4 ± 4.7	1.0	22	---
156	3	Room B-309c	B	Door	Jamb-Lft		Metal		0.06 ± 0.10	NI:G	0.3 ± 6.1	2.6	22	---
157	3	Room B-309c		Floor	Header		Tile		0.13 ± 0.17	NI:G	-0.2 ± 5.9	3.6	22	---
158	3	Room B-309c		Floor			Tile		0.14 ± 0.19	NI:G	-1.5 ± 3.2	4.0	23	---

Room B-309b

Site: V.A.M.C. Date: 01/23/97

Ranges (NEG<INC<POS): 0.0<1.00<1.00 Times: minL = 5 Ssec minK = 60 Ssec

XLNo	Fir	Room	Side	Structure	Feature	Cond.	Substr.	P.C. Sample	PbL(mg/cm ²)	RES	PbK	DI	Ssec	Final Result
139	3	Room B-309b		Wall-A	Wall-1 pr		Plaster		0.08 ± 0.07	NEG	-1.2 ± 3.0	2.0	23	---
140	3	Room B-309b		Wall-B	Middle Wall		Plaster		0.05 ± 0.07	NEG	-2.5 ± 3.4	1.9	22	---
141	3	Room B-309b		Wall-C	Middle Wall		Plaster		0.04 ± 0.03	NEG	-2.1 ± 3.1	1.1	22	---
142	3	Room B-309b		Wall-C	Rad. Cover*		Metal		0.15 ± 0.08	NEG	0.3 ± 5.5	2.3	23	---
143	3	Room B-309b		Window	Mullion*		Wood		>5.0 ± 1.00	POS	5.0 ± 12.7	2.8	29	POS
144	3	Room B-309b		Wall	Panel*		Metal		0.01 ± 0.06	NEG	2.1 ± 9.1	1.4	22	---
145	3	Room B-309b		Wall	Panel*		Metal		0.01 ± 0.05	NEG	1.1 ± 7.5	1.3	21	---
146	3	Room B-309b		Ceiling	DC Grid*		Metal		0.03 ± 0.09	NEG	-0.3 ± 4.8	2.4	21	---

Room B-309a
 Site: V.A.M.C. Date: 01/23/97
 Ranges (NEG<INC<POS): 0.0<1.00<1.00 Times: minL = 5 Ssec minK = 60 Ssec

XLNo	Fir	Room	Side	Structure	Feature	Cond.	Substr.	P.C. Sample	PbL(mg/cm ²)	RES	PbK	DI	Ssec	Final Result
130	3	Room B-309a		Wall-A	Wall-Up*		Plaster		0.06 ± 0.05	NEG	-0.4 ± 4.6	1.5	22	---
131	3	Room B-309a		Wall-B	Middle Wall		Plaster		0.05 ± 0.04	NEG	-1.6 ± 2.7	1.4	23	---
132	3	Room B-309a		Wall-B	Rad. Cover*		Metal		0.09 ± 0.05	NEG	0.6 ± 6.0	1.7	25	---
133	3	Room B-309a		Window-B	Casing*-Rht		Wood		2.60 ± 0.69	POS	1.5 ± 11.4	3.7	10	POS
134	3	Room B-309a		Window-B	Blind*		Metal		0.00 ± 0.04	NEG	-1.8 ± 3.3	1.0	22	---
135	3	Room B-309a		Ceiling	DC Grid*		Metal		0.01 ± 0.01	NEG	1.6 ± 7.0	1.0	36	---
136	3	Room B-309a		Ceiling	DC Grid*		Metal		0.01 ± 0.01	NEG	0.2 ± 5.5	1.0	22	---
137	3	Room B-309a		Cabinet-B	Door-Out		Metal		0.02 ± 0.02	NEG	0.9 ± 5.5	1.2	33	---
138	3	Room B-309a		Cabinet-B	Door-Out		Metal		0.05 ± 0.01	NEG	0.6 ± 6.3	1.0	21	---

Room B-309

Site: V.A.M.C. Date: 01/23/97

Ranges (NEG<INC<POS): 0.0<1.00<1.00 Times: minL = 5 Ssec minK = 60 Ssec

XLNo	Flr	Room	Side	Structure	Feature	Cond.	Substr.	P.C. Sample	PbL(mg/cm ²)	RES	PbK	DI	Ssec	Final Result
103	3	Room B-309		Wall-A			Plaster		0.05 ± 0.04	NEG	-1.7 ± 2.7	1.2	22	---
104	3	Room B-309		Wall-B			Plaster		0.12 ± 0.27	NEG	-1.8 ± 3.1	5.4	25	---
105	3	Room B-309		Wall-C			Plaster		0.11 ± 0.10	NEG	-2.3 ± 3.4	2.7	22	---
106	3	Room B-309		Wall-C	Rad. Cover*		Metal		0.08 ± 0.04	NEG	-0.8 ± 3.0	1.3	22	---
107	3	Room B-309		Door	Door		Wood		0.01 ± 0.03	NEG	-1.1 ± 2.3	1.0	21	---
108	3	Room B-309	B	Door	Door		Wood		0.01 ± 0.01	NEG	-1.8 ± 2.7	1.0	22	---
109	3	Room B-309	C	Door	Door		Wood		0.00 ± 0.01	NEG	-1.1 ± 2.4	1.0	25	---
110	3	Room B-309	C	Door	Casing-Rht		Metal		0.16 ± 0.08	NEG	0.8 ± 6.5	2.2	25	---
111	3	Room B-309	B	Door	Jamb-Rht		Metal		0.09 ± 0.08	NEG	-0.7 ± 3.7	2.4	22	---
112	3	Room B-309	B	Door	Header		Metal		0.11 ± 0.07	NEG	-1.3 ± 2.6	2.2	25	---
113	3	Room B-309		Ceiling	Pan *		Metal		0.00 ± 0.06	NEG	0.0 ± 4.1	1.0	23	---
114	3	Room B-309		Wall-A	Wall-Uptr		Plaster		0.14 ± 0.15	NEG	-1.5 ± 2.7	3.6	22	---
115	3	Room B-309		Wall-B	Middle Wall		Plaster		0.10 ± 0.07	NEG	-1.9 ± 2.6	1.9	22	---
116	3	Room B-309		Wall-C	Middle Wall		Plaster		0.07 ± 0.11	NEG	-0.1 ± 5.8	2.7	23	---
117	3	Room B-309		Window	Mullion*		Metal		>>5.0 ± 1.00	POS	4.0 ± 17.1	4.7	13	POS
118	3	Room B-309		Window	Blind*		Metal		0.00 ± 0.00	NEG	-1.5 ± 2.9	1.0	22	---
119	3	Room B-309		Ceiling	DC Grid*		Metal		0.02 ± 0.07	NEG	-0.1 ± 4.3	2.0	21	---
120	3	Room B-309	A	Door-1	Casing-Rht		Metal		0.05 ± 0.05	NEG	-2.0 ± 2.9	1.8	22	---
121	3	Room B-309	B	Door-1	Casing-Lft		Metal		0.04 ± 0.04	NEG	-1.3 ± 3.2	1.3	22	---
122	3	Room B-309	B	Door-2	Door		Metal		0.04 ± 0.04	NEG	-0.4 ± 5.2	1.4	23	---
123	3	Room B-309	B	Door-2	Header		Metal		0.05 ± 0.04	NEG	0.8 ± 6.7	1.5	22	---
124	3	Room B-309		Wall-B	Wall-Uptr		Plaster		0.04 ± 0.03	NEG	-1.7 ± 2.6	1.2	23	---
125	3	Room B-309		Wall-C	Middle Wall		Plaster		0.06 ± 0.06	NEG	-1.1 ± 3.2	1.8	22	---
126	3	Room B-309	A	Door	Door		Wood		0.00 ± 0.00	NEG	-0.5 ± 3.9	1.0	21	---
127	3	Room B-309	B	Door	Door		Wood		0.00 ± 0.00	NEG	-0.6 ± 2.8	1.0	22	---
128	3	Room B-309	A	Door	Casing-Lft		Metal		0.03 ± 0.03	NEG	0.0 ± 6.0	1.2	22	---
129	3	Room B-309	B	Door	Header		Metal		0.02 ± 0.01	NEG	0.8 ± 7.8	1.0	22	---

Room B-308

Site: V.A.M.C. Date: 01/17/97

Ranges (NEG<INC<POS): 0.0<1.00<1.00 Times: minL = 5 Ssec minK = 60 Ssec

XLNo	Fir	Room	Side	Structure	Feature	Cond.	Substr.	P.C. Sample	PbL(mg/cm ²)	RES	PbK	DI	Ssec	Final Results
7	3	Room B-308		Wall-B	Wall-Upr		Drywall		0.30 ± ***	NEG	-1.0 ± 1.4	10.0	61	---
8	3	Room B-308		Wall-C	Middle Wall		Plaster		0.20 ± 0.20	NEG	-1.2 ± 3.4	4.4	23	---
9	3	Room B-308		Wall-C	Wall-Lwr		Plaster		0.12 ± 0.12	NEG	0.1 ± 6.6	2.8	22	---
10	3	Room B-308		Wall-C	Rad Cover*		Metal		0.13 ± 0.19	NEG	-1.0 ± 2.5	4.3	22	---
11	3	Room B-308		Window-C	Casing-Lft		Wood		2.43 ± ***	---	1.0 ± 8.2	10.0	15	POS
12	3	Room B-308		Window-C	Blind*		Metal		0.19 ± 0.08	NEG	-1.4 ± 3.0	2.0	22	---
13	3	Room B-308	A	Door	Door		Wood		0.00 ± 0.06	NEG	-0.8 ± 2.2	1.0	21	---
15	3	Room B-308	B	Door	Door		Wood		0.00 ± 0.06	NEG	-0.7 ± 2.1	1.0	21	---
16	3	Room B-308	A	Door	Casing-Rht		Metal		0.00 ± 0.05	NEG	-1.3 ± 2.7	1.0	22	---
17	3	Room B-308	B	Door	Casing-Rht		Metal		0.00 ± 0.03	NEG	-0.2 ± 5.2	1.0	22	---
18	3	Room B-308	B	Door	Header		Metal		0.00 ± 0.01	NEG	-0.8 ± 2.7	1.0	22	---
19	3	Room B-308		Ceiling	DC Grid*		Metal		0.01 ± 0.07	NEG	-0.9 ± 2.4	1.7	20	---
20	3	Room B-308		Ceiling	Diffuser*		Metal		0.04 ± 0.08	NEG	-1.1 ± 2.3	6.7	21	---

Room B-304

Site: V.A.M.C. Date: 01/24/97

Ranges (NEG<INC<POS): 0.0<1.00<1.00 Times: minL = 5 Ssec minK = 60 Ssec

XLNo	Fr	Room	Side	Structure	Feature	Cond.	Substr.	P.C. Sample	PbL(mg/cm ²)	RES	PbK	DI	Ssec	Final Result
118	3	Room B-304		Wall-A	Wall-Up		Drywall		0.20 ± 0.13	NEG	-2.9 ± 3.4	3.1	22	—
119	3	Room B-304		Wall-C	Wall-Up		Plaster		0.15 ± 0.12	NEG	-1.7 ± 3.1	3.0	22	—
120	3	Room B-304		Wall-D	Wall-Up		Plaster		0.16 ± 0.11	NEG	-1.6 ± 3.1	2.6	22	—
121	3	Room B-304		Wall-C	Wall Rgstr		Metal		0.16 ± ***	NEG	-0.9 ± 1.5	10.0	61	—
122	3	Room B-304		Wall-C	Wall Rgstr*		Metal		0.12 ± ***	INC	0.1 ± 3.2	10.0	61	NEG
123	3	Room B-304		Ceiling	Pan*		Metal		0.01 ± 0.02	NEG	-1.1 ± 2.2	1.0	22	—
124	3	Room B-304		Wall-A	Wall-Up		Plaster		0.04 ± 0.05	NEG	-0.1 ± 4.5	1.5	22	—
125	3	Room B-304		Wall-A	Middle Wall		Plaster		0.11 ± 0.06	NEG	0.0 ± 5.8	1.5	22	—
126	3	Room B-304		Wall-D	Middle Wall		Plaster		0.12 ± 0.07	NEG	-1.8 ± 3.2	1.8	22	—
127	3	Room B-304	A	Door	Door		Wood		0.01 ± 0.02	NEG	-0.2 ± 3.7	1.0	22	—
128	3	Room B-304	B	Door	Door		Wood		0.00 ± 0.00	NEG	-1.6 ± 2.9	1.0	21	—
129	3	Room B-304	C	Door	Door		Wood		0.01 ± 0.04	NEG	-0.7 ± 2.2	1.0	22	—
130	3	Room B-304	A	Door	Casing-Rht		Metal		0.07 ± 0.04	NEG	-1.4 ± 3.2	1.5	22	—
131	3	Room B-304	B	Door	Casing-Rht		Metal		0.19 ± 0.04	NEG	1.3 ± 5.1	2.1	61	—
132	3	Room B-304	B	Door	Casing-Lft		Metal		0.19 ± 0.09	NEG	-0.7 ± 4.2	2.2	22	—
133	3	Room B-304		Ceiling	Pan*		Metal		0.00 ± 0.01	NEG	1.3 ± 6.4	1.0	26	—
134	3	Room B-304		Ceiling	Pan*		Metal		0.00 ± 0.00	NEG	-1.7 ± 2.7	1.0	22	—

Room B-303

Site: V.A.M.C. Date: 01/24/97

Ranges (NEG<INC<POS): 0.0<1.00<1.00 Times: minL = 5 Ssec minK = 60 Ssec

XLNo	Flr	Room	Side	Structure	Feature	Cond.	Substr.	P.C. Sample	PbL(mg/cm ²)	RES	PbK	DI	Ssec	Final Result
152	3	Room B-303		Wall-B	Wall-Upr		Plaster		0.12 ± 0.12	NEG	-1.7 ± 2.6	2.9	22	—
153	3	Room B-303		Wall-D	Middle Wall		Plaster		0.06 ± 0.07	NEG	-1.2 ± 2.8	2.0	22	—
154	3	Room B-303		Wall-A	Wall-Upr		Plaster		0.17 ± 0.21	NEG	-0.1 ± 6.3	4.4	22	—
155	3	Room B-303		Wall-B	Wall-Lwr		Tile		>>5.0 ± 1.00	POS	5.3 ± 25.5	1.8	6	POS
156	3	Room B-303		Wall-C	Wall-Lwr		Tile		0.58 ± 0.16	NEG	0.8 ± 8.7	2.0	15	—
157	3	Room B-303		Wall-C	Wall-Lwr		Tile		0.77 ± 0.16	NEG	-1.6 ± 3.2	2.1	21	—
158	3	Room B-303		Wall-D	Wall-Lwr		Tile		>>5.0 ± 1.00	POS	3.8 ± 21.7	1.8	6	POS
159	3	Room B-303		Floor	Wall		Tile		0.14 ± 0.30	NEG	-1.8 ± 3.3	5.8	22	—
160	3	Room B-303		Floor	Wall		Tile		0.15 ± 0.23	NEG	-2.3 ± 3.7	4.4	22	—
161	3	Room B-303	A	Door	Door		Wood		0.06 ± -0.04	NEG	-1.2 ± 2.3	7.8	22	—
162	3	Room B-303	B	Door	Door		Wood		0.00 ± 0.01	NEG	-0.6 ± 2.4	1.0	22	—
163	3	Room B-303	A	Door	Casing-Rht		Metal		0.06 ± 0.07	NEG	-1.0 ± 3.3	2.2	22	—
164	3	Room B-303	B	Door	Casing-Rht		Metal		0.10 ± 0.14	NEG	0.1 ± 5.8	3.3	22	—
165	3	Room B-303	B	Door	Header		Metal		0.11 ± 0.17	NEG	-0.4 ± 4.6	3.9	22	—
166	3	Room B-303		Cabinet-D	Shelf		Metal		0.00 ± 0.00	NEG	0.1 ± 5.4	1.0	21	—
167	3	Room B-303		Cabinet-D	Door-Ins		Metal		0.00 ± 0.01	NEG	0.3 ± 5.8	1.0	22	—
168	3	Room B-303		Ceiling	DC Grid*		Metal		0.04 ± 0.16	NEG	-0.8 ± 2.8	4.0	21	—

Room B-302

Site: V.A.M.C. Date: 01/24/97

Ranges (NEG<INC<POS): 0.0<1.00<1.00 Times: minL = 5 Ssec minK = 60 Ssec

XLNo	Fir	Room	Side	Structure	Feature	Cond.	Substr.	P.C. Sample	PbL(mg/cm ²)	RES	PbK	DI	Ssec	Final Result
88	3	Room B-302		Wall-B	Panel*		Metal		0.00 ± 0.08	NEG	-0.3 ± 5.1	1.3	22	—
89	3	Room B-302		Wall-B	Panel*		Metal		0.00 ± 0.01	NEG	-1.2 ± 3.1	1.0	22	—
90	3	Room B-302		Wall-C	Radiator		Metal		0.09 ± 0.08	NEG	-1.3 ± 2.6	2.4	22	—
91	3	Room B-302		Window	Casing-Lft		Wood		3.59 ± 2.50	POS	1.3 ± 12.4	4.9	8	POS
92	3	Room B-302		Ceiling	DC Grid*		Metal		0.07 ± 0.16	NEG	0.0 ± 4.1	5.7	25	—
93	3	Room B-302	A	Door	Door		Wood		0.00 ± 0.00	NEG	-0.7 ± 2.4	1.0	21	—
94	3	Room B-302	B	Door	Door		Wood		0.00 ± 0.00	NEG	-1.0 ± 2.2	1.0	22	—
95	3	Room B-302	A	Door	Casing-Rht		Metal		0.18 ± 0.22	NEG	-0.4 ± 5.4	5.1	24	—
96	3	Room B-302	B	Door	Casing-Rht		Metal		0.12 ± 0.17	NEG	-0.8 ± 2.9	7.3	32	—
97	3	Room B-302	B	Door	Header		Metal		0.07 ± 0.10	NEG	-1.5 ± 3.3	2.7	22	—
98	3	Room B-302		Wall-B	Wall-Lwr		Tile		>>5.0 ± 1.00	POS	13.9 ± 26.3	1.7	25	POS
99	3	Room B-302		Wall-C	Middle Wall		Tile		>>5.0 ± 1.00	POS	8.7 ± 33.3	1.9	6	POS
100	3	Room B-302		Wall-D	Wall-Lwr		Tile		>>5.0 ± 1.00	POS	7.2 ± 29.5	1.6	6	POS
101	3	Room B-302	A	Door	Door		Wood		0.00 ± 0.00	NEG	-1.1 ± 2.3	1.0	21	—
102	3	Room B-302	A	Door	Door		Wood		0.00 ± 0.00	NEG	-0.7 ± 2.8	1.0	21	—
103	3	Room B-302	A	Door	Casing-Rht		Metal		0.02 ± 0.16	NEG	-1.6 ± 2.7	2.8	22	—
104	3	Room B-302	B	Door	Jamb-Rht		Metal		0.01 ± 0.05	NEG	0.2 ± 5.3	1.2	22	—
105	3	Room B-302	A	Door	Header		Metal		0.01 ± 0.07	NEG	0.2 ± 5.7	1.4	22	—
106	3	Room B-302		Ceiling	DC Grid*		Metal		0.05 ± 0.23	NEG	-0.5 ± 5.5	3.8	11	—

Room B-300

Site: V.A.M.C. Date: 01/24/97

Ranges (NEG<INC<POS): 0.0<1.00<1.00 Times: minL = 5 Ssec minK = 60 Ssec

XLNo	Fir	Room	Side	Structure	Feature	Cond.	Substr.	P.C. Sample	PbL(mg/cm ²)	RES	PbK	DI	Ssec	Final Result
107	3	Room B-300		Wall-A	Wall-Up		Plaster		0.01 ± 0.06	NEG	-1.5 ± 2.6	1.3	22	---
108	3	Room B-300		Wall-B	Middle Wall		Plaster		0.00 ± 0.10	NEG	-1.3 ± 2.5	1.0	22	---
109	3	Room B-300		Wall-C	Wall-Lwr		Plaster		0.01 ± 0.03	NEG	-1.8 ± 3.2	1.0	23	---
110	3	Room B-300		Wall-C	Radiator*		Metal		0.12 ± 0.15	NEG	0.8 ± 7.0	3.8	22	---
111	3	Room B-300		Window-C	Blind*		Metal		0.00 ± 0.11	NEG	-3.0 ± 3.3	1.2	22	---
112	3	Room B-300	A	Door	Door		Wood		0.01 ± 0.03	NEG	-0.9 ± 2.2	1.0	22	---
113	3	Room B-300	B	Door	Door		Wood		0.01 ± 0.04	NEG	-1.1 ± 2.3	1.0	21	---
114	3	Room B-300	A	Door	Casing-Rht		Metal		0.01 ± 0.05	NEG	-2.3 ± 3.1	1.3	22	---
115	3	Room B-300	B	Door	Casing-Rht		Metal		0.06 ± 0.09	NEG	-1.5 ± 2.8	2.3	22	---
116	3	Room B-300	A	Door	Header		Metal		0.01 ± 0.02	NEG	-2.0 ± 2.8	1.0	22	---
117	3	Room B-300		Ceiling	DC Grid*		Metal		0.03 ± 0.11	NEG	-1.4 ± 3.0	2.7	20	---

B-331

Site: V.A.M.C. Date: 01/23/97

Ranges (NEG<INC<POS): 0.0<1.00<1.00 Times; minL = 20 Ssec minK = 60 Ssec

XLNo	Fir	Room	Side	Structure	Feature	Substr.	P.C. Sample	PbL(mg/cm ²)	RES	PbK	DI	Ssec	Final Result
159	3	Room B-331		Wall-A	Feature	Plaster		0.11 ± 0.05	NEG	-1.6 ± 3.8	1.3	22	---
160	3	Room B-331		Wall-D	Wall-Upr	Plaster		0.12 ± 0.05	NEG	-2.1 ± 3.5	1.4	22	---
161	3	Room B-331		Wall-D	Midle Wall	Plaster		0.11 ± 0.05	NEG	-0.1 ± 6.1	1.3	22	---
162	3	Room B-331		Door	Wall-Lwr	Wood		0.00 ± 0.00	NEG	-1.1 ± 2.5	1.0	21	---
163	3	Room B-331	A	Door	Door	Wood		0.01 ± 0.09	NEG	-1.3 ± 2.4	1.0	21	---
164	3	Room B-331	B	Door	Door	Wood		0.03 ± 0.08	NEG	-0.7 ± 3.3	1.3	21	---
165	3	Room B-331	C	Door	Door	Wood		0.14 ± 0.06	NEG	0.7 ± 5.9	1.6	22	---
166	3	Room B-331	A	Door	Jamb-Lft	Metal		0.15 ± 0.09	NEG	-1.0 ± 3.3	2.5	22	---
167	3	Room B-331	B	Door	Casing-Lft	Metal		0.13 ± 0.07	NEG	-0.8 ± 3.4	2.0	22	---
168	3	Room B-331	B	Door	Header	Metal		0.08 ± 0.05	NEG	-0.9 ± 4.2	1.4	22	---
169	3	Room B-331		Ceiling		Plaster		0.05 ± 0.05	NEG	-1.5 ± 2.8	1.5	23	---
170	3	Room B-331		Floor		Concrte		0.09 ± 0.09	NEG	-1.8 ± 3.1	2.4	22	---
				Floor		Concrte							---

B-322
 Site: V.A.M.C. Date: 01/24/97
 Ranges (NEG<INC<POS): 0.0<1.00<1.00 Times: minL = 20 Ssec minK = 60 Ssec

CLNo	Fir	Room	Side	Structure	Feature	Substr.	P.C. Sample	PbL(mg/cm ²)	RES	PbK	DI	Ssec	Final Result
58	3	Room B-322		Wall-A	Wall-Up	Plaster		0.29 ± 0.11	NEG	-2.3 ± 3.2	2.3	22	---
59	3	Room B-322		Wall-D	Middle Wall	Plaster		0.28 ± 0.10	NEG	-1.7 ± 3.0	2.1	22	---
60	3	Room B-322		Wall-C	Wall-Lwr	Plaster		0.26 ± 0.08	NEG	-1.7 ± 3.5	1.8	22	---
61	3	Room B-322		Floor		Concrte		0.11 ± 0.05	NEG	-0.2 ± 5.7	1.5	27	---
62	3	Room B-322		Floor		Concrte		0.10 ± 0.05	NEG	-1.6 ± 2.9	1.5	22	---
63	3	Room B-322	A	Door	Door	Wood		0.01 ± 0.07	NEG	-0.6 ± 1.8	1.0	22	---
64	3	Room B-322	B	Door	Door	Wood		0.00 ± 0.00	NEG	-0.3 ± 2.1	1.0	22	---
65	3	Room B-322	A	Door	Casing-Lft	Metal		0.11 ± 0.04	NEG	0.6 ± 6.4	1.3	27	---
66	3	Room B-322	B	Door	Casing-Lft	Metal		0.16 ± 0.13	NEG	0.3 ± 5.9	3.3	23	---
67	3	Room B-322	B	Door	Header	Metal		0.14 ± 0.04	NEG	-0.7 ± 4.7	1.2	24	---
68	3	Room B-322		Ceiling	Diffuser*	Metal		0.23 ± 0.08	NEG	-0.9 ± 3.6	2.0	22	---
69	3	Room B-322		Ceiling	Pan*	Plaster		0.21 ± 0.09	NEG	-1.3 ± 2.6	2.2	22	---
70	3	Room B-322		Wall-A	Wall Rgstr	Metal		0.01 ± 0.00	NEG	-0.2 ± 3.6	1.0	22	---
71	3	Room B-322		Wall-A	Wall Rgstr	Metal		0.01 ± 0.00	NEG	-0.1 ± 4.3	1.0	22	---

Room B-316

Site: V.A.M.C. Date: 01/24/97

Ranges (NEG<INC<POS): 0.0<1.00<1.00 Times: minL = 5 Ssec minK = 60 Ssec

No	Fir	Room	Side	Structure	Feature	Cond.	Substr.	P.C. Sample	PbL(mg/cm ²)	RES	PbK	DI	Ssec	Final Result
2	3	Room B-316		Wall-A	Middle Wall		Plaster		0.14 ± 0.28	NEG	-1.4 ± 2.5	5.8	22	—
3	3	Room B-316		Wall-B	Wall-Up		Plaster		0.13 ± 0.13	NEG	-1.7 ± 2.6	3.1	22	—
4	3	Room B-316		Wall-C	Middle Wall		Plaster		0.01 ± 0.03	NEG	-0.8 ± 2.7	1.0	22	—
5	3	Room B-316		Wall-B	Baseboard		Tile		>>5.0 ± 1.00	POS	14.7 ± 43.3	1.7	6	POS
5	3	Room B-316		Wall-C	Baseboard		Tile		>>5.0 ± 1.00	POS	3.5 ± 23.1	1.9	6	POS
7	3	Room B-316		Wall-A	Baseboard		Tile		>>5.0 ± 1.00	POS	3.3 ± 22.7	1.7	6	POS
3	3	Room B-316		Floor			Tile		0.20 ± 0.29	NEG	-1.2 ± 2.6	5.4	22	—
3	3	Room B-316		Floor			Tile		0.13 ± 0.27	NEG	-1.7 ± 2.7	4.6	22	—
3	3	Room B-316		Wall-2	Middle Wall		Metal		0.48 ± ***	NEG	-0.8 ± 1.3	10.0	60	—
3	3	Room B-316		Wall-2	Middle Wall		Metal		0.05 ± 0.04	NEG	-1.1 ± 2.3	1.3	22	—
3	3	Room B-316		Wall-2	Middle Wall		Metal		0.07 ± 0.06	NEG	0.0 ± 4.7	1.8	22	—
3	3	Room B-316	A	Door	Door		Wood		0.00 ± 0.00	NEG	0.1 ± 4.4	1.0	21	—
3	3	Room B-316	B	Door	Door		Wood		0.00 ± 0.07	NEG	-0.6 ± 1.9	1.0	22	—
3	3	Room B-316	A	Door	Door		Metal		0.00 ± 0.04	NEG	-1.0 ± 2.5	1.0	22	—
3	3	Room B-316	B	Door	Casing-Rht		Metal		0.00 ± 0.00	NEG	-1.8 ± 2.6	1.0	23	—
3	3	Room B-316	B	Door	Header		Metal		0.00 ± 0.01	NEG	-0.8 ± 3.9	1.0	22	—
3	3	Room B-316	B	Door	Header		Metal		0.16 ± 0.20	NEG	-1.6 ± 3.0	4.6	22	—
3	3	Room B-316		Wall-A	Panel*		Metal	(6-3)* <0.01%	0.26 ± ***	...	1.4 ± 6.9	10.0	30	NEG
3	3	Room B-316		Wall-A	Panel*		Metal	(6-3)* <0.01%	0.22 ± ***	INC	-0.4 ± 2.4	10.0	60	NEG
3	3	Room B-316		Ceiling	Panel*		Metal		0.03 ± 0.14	NEG	-1.8 ± 2.6	2.6	22	—

Ranges (NE

= 60 Ssec

XLNo	Flr	Room	Side	Structure	PbL(mg/cm ²)	RES	DI	Ssec	Final Result
88	2	Room B-239		Wall-A	0.14 ± 0.13	NEG	3.1	23	---
89	2	Room B-239		Wall-B	0.35 ± 0.42	---	3.9	6	---
90	2	Room B-239		Wall-B	0.17 ± 0.09	NEG	2.3	22	---
91	2	Room B-239		Wall-D	0.00 ± 0.07	NEG	1.0	22	---
92	2	Room B-239		Wall-B	>5.0 ± 1.00	POS	1.9	13	POS
93	2	Room B-239	A	Door	0.00 ± 0.04	NEG	1.0	21	---
94	2	Room B-239	B	Door	0.03 ± 0.02	NEG	1.0	21	---
95	2	Room B-239	C	Door	0.01 ± 0.01	NEG	1.0	21	---
96	2	Room B-239	A	Door	0.16 ± 0.08	NEG	2.1	23	---
97	2	Room B-239	B	Door	0.31 ± 0.12	NEG	2.7	22	---
98	2	Room B-239	B	Door	0.30 ± 0.10	NEG	2.2	22	---
99	2	Room B-239		Ceiling	0.29 ± 0.18	NEG	3.9	22	---
101	2	Room B-239		Wall	0.20 ± 0.18	NEG	4.1	22	---
102	2	Room B-239		Ceiling	0.25 ± 0.17	NEG	4.0	22	---

2ND FLOOR

LEAD SURVEY

Room B-238

Site: V.A.M.C. Date: 01/09/97

Ranges (NEG<INC<POS): 0.0<1.00<1.00 Times: minL = 7 Ssec minK = 60 Ssec

XLNo	Fir	Room	Side	Structure	Feature	Cond.	Substr.	P.C. Sample	PbL(mg/cm ²)	RES	DI	Ssec	Final Result
109	2	Room B-238	A	Ceiling	DC Grid*		Metal		0.00 ± 0.01	NEG	1.0	21	---
110	2	Room B-238	A	Ceiling	DC Grid*		Drywall		0.02 ± 0.13	NEG	3.7	25	---
111	2	Room B-238	A	Door-2	Casing-Rht		Metal		0.13 ± ***	...	9.0	22	NEG
112	2	Room B-238	A	Door-2	Jamb-Lft		Metal		0.02 ± 0.14	NEG	2.8	22	---
113	2	Room B-238	A	Door-2	Header		Metal		0.02 ± 0.10	NEG	2.1	22	---
114	2	Room B-238	A	Ceiling	Radiator *		Metal		0.01 ± 0.09	NEG	3.7	22	---
115	2	Room B-238	A	Door-1	Door		Wood		0.00 ± 0.07	NEG	1.0	21	---
116	2	Room B-238	B	Door-1	Door		Wood		0.00 ± 0.07	NEG	1.0	21	---
117	2	Room B-238	C	Door-1	Door		Wood		0.00 ± 0.00	NEG	1.0	21	---
118	2	Room B-238	A	Door-1	Casing-Rht		Metal		0.13 ± 0.10	NEG	2.7	22	---
119	2	Room B-238	B	Door-1	Jamb-Rht		Metal		0.41 ± 0.14	NEG	2.8	22	---
120	2	Room B-238	B	Door-1	Header		Metal		0.70 ± 0.17	NEG	4.0	39	---

Room B-237

Site: V.A.M.C. Date: 01/09/97

Ranges (NEG<INC<POS): 0.0<1.00<1.00 Times: minL = 7 Ssec minK = 60 Ssec

XLNo	Flr	Room	Side	Structure	Feature	Cond.	Substr.	P.C. Sample	PbL(mg/cm ²)	RES	DI	Ssec	Final Result
76	2	Room B-237		Wall-A	Wall-Up		Plaster		0.13 ± 0.10	NEG	2.5	22	---
77	2	Room B-237		Wall-B	Middle Wall		Plaster		0.11 ± 0.07	NEG	1.9	22	---
78	2	Room B-237		Wall-D	Middle Wall		Plaster		0.09 ± 0.06	NEG	1.8	22	---
79	2	Room B-237		Wall-A	Baseboard		Tile		>>5.0 ± 1.00	...	1.8	6	POS
80	2	Room B-237	A	Door	Door		Wood		0.00 ± 0.00	NEG	1.0	21	---
81	2	Room B-237	B	Door	Door		Wood		0.01 ± 0.02	NEG	1.0	22	---
82	2	Room B-237	C	Door	Door		Wood		0.03 ± 0.07	NEG	1.2	21	---
83	2	Room B-237	A	Door	Casing-Rht		Metal		0.11 ± 0.04	NEG	1.6	32	---
84	2	Room B-237	B	Door	Jamb-Lft		Metal		0.11 ± 0.06	NEG	2.2	35	---
85	2	Room B-237	B	Door	Header		Metal		0.18 ± 0.11	NEG	2.9	22	---
86	2	Room B-237		Ceiling	DC Grid*		Metal		0.01 ± 0.03	NEG	1.1	21	---
87	2	Room B-237		Floor			Tile		0.15 ± 0.26	NEG	4.7	22	---

Room B-236

Site: V.A.M.C. Date: 01/09/97

Ranges (NEG<INC<POS): 0.0<1.00<1.00 Times: minL = 7 Ssec minK = 60 Ssec

XLNo	Fir	Room	Side	Structure	Feature	Cond.	Substr.	P.C. Sample	PbL(mg/cm ²)	RES	DI	Ssec	Final Result
63	2	Room B-236		Wall-A	Wall-Up	Solid	Plaster		0.08 ± 0.07	NEG	2.0	22	---
64	2	Room B-236		Wall-B	Middle Wall	Solid	Plaster		0.16 ± 0.18	NEG	3.9	22	---
65	2	Room B-236		Wall-D	Wall-Lwr	Solid	Plaster		0.03 ± 0.10	NEG	2.0	22	---
66	2	Room B-236		Wall-B	Radiator *	Solid	Metal		0.11 ± 0.08	NEG	2.4	22	---
67	2	Room B-236		Window	Mullion*	Solid	Wood		2.54 ± 1.12	POS	5.6	8	POS
68	2	Room B-236	A	Door	Door	Solid	Wood		0.01 ± 0.04	NEG	1.0	21	---
69	2	Room B-236	B	Door	Door	Solid	Wood		0.01 ± 0.01	NEG	1.0	37	---
70	2	Room B-236	C	Door	Door	Solid	Wood		0.02 ± 0.02	NEG	1.0	21	---
72	2	Room B-236	B	Door	Jamb-Rht		Metal		0.10 ± 0.07	NEG	2.0	22	---
74	2	Room B-236		Ceiling	DC Grid*		Metal		0.00 ± 0.00	NEG	1.0	20	---
75	2	Room B-236		Ceiling	Radiator *		Metal		0.03 ± 0.09	NEG	2.3	22	---

Room B-233

Site: V.A.M.C. Date: 01/14/97

Ranges (NEG<INC<POS): 0.0<1.00<1.00 Times: minL = 5 Ssec minK = 60 Ssec

XLNo	Fir	Room	Side	Structure	Feature	Cond.	Substr.	P.C. Sample	PbL(mg/cm ²)	RES	PbK	DI	Ssec	Final Result
215	2	Room B-233		Wall-A	Wall-Uptr		Drywall		0.06 ± 0.17	NEG	-1.2 ± 2.4	5.3	25	---
216	2	Room B-233		Wall-B	Middle Wall		Drywall		0.00 ± 0.00	NEG	-0.8 ± 2.9	1.0	22	---
217	2	Room B-233		Wall-C	Wall-Lwr		Plaster		0.11 ± 0.08	NEG	-2.7 ± 3.4	2.2	22	---
218	2	Room B-233		Window-C	Stool*		Wood		2.23 ± 0.62	POS	0.5 ± 7.5	4.3	13	POS
219	2	Room B-233		Window-C	Blind*		Metal		0.00 ± 0.17	NEG	0.5 ± 12.8	1.0	5	---
220	2	Room B-233		Window-C	Blind*		Metal		0.00 ± 0.10	NEG	-1.0 ± 2.3	1.3	22	---
221	2	Room B-233	A	Door	Door		Wood		0.00 ± 0.00	NEG	-0.8 ± 2.3	1.0	21	---
222	2	Room B-233	B	Door	Door		Wood		0.00 ± 0.00	NEG	0.0 ± 4.1	1.0	25	---
223	2	Room B-233	A	Door	Door		Wood		0.00 ± 0.00	NEG	0.6 ± 6.9	1.0	21	---
224	2	Room B-233	A	Door	Jamb-Lft		Metal		0.03 ± 0.04	NEG	-0.8 ± 3.4	1.4	22	---
225	2	Room B-233	B	Door	Casing-Lft		Metal		0.04 ± 0.06	NEG	0.7 ± 6.6	2.0	25	---
226	2	Room B-233	A	Door	Header		Metal		0.07 ± 0.06	NEG	0.6 ± 6.9	1.9	22	---
227	2	Room B-233		Ceiling	DC Grid*		Metal		0.05 ± 0.20	NEG	-0.6 ± 3.5	4.1	21	---
228	2	Room B-233		Ceiling	Diffuser*		Metal		0.02 ± 0.12	NEG	-0.9 ± 2.3	4.0	25	---

Room B-226

Site: V.A.M.C. Date: 01/08/97

Ranges (NEG<INC<POS): 0.0<1.00<1.00 Times: minL = 5 Ssec minK = 60 Ssec

XLNo	Flr	Room	Side	Structure	Feature	Cond.	Substr.	P.C. Sample	PbL(mg/cm ²)	RES	PbK	DI	Ssec	Final Result
97	2	Room B-226		Wall-A	Wall-Upr		Plaster		0.09 ± 0.06	NEG	-1.8 ± 2.9	1.7	23	—
98	2	Room B-226		Wall-B	Middle Wall		Plaster		0.12 ± 0.08	NEG	-2.1 ± 3.0	2.1	22	—
99	2	Room B-226		Wall-C	Middle Wall		Plaster		0.19 ± 0.10	NEG	-2.3 ± 3.2	2.3	22	—
100	2	Room B-226	A	Door	Door		Wood		0.01 ± 0.01	NEG	-1.3 ± 2.4	1.0	21	—
101	2	Room B-226	B	Door	Door		Wood		0.00 ± 0.00	NEG	-1.2 ± 2.3	1.0	21	—
102	2	Room B-226	C	Door	Door		Wood		0.00 ± 0.10	NEG	-1.1 ± 2.3	1.0	21	—
103	2	Room B-226	A	Door	Casing-Lft		Metal		0.22 ± 0.09	NEG	-1.7 ± 2.9	2.3	22	—
104	2	Room B-226	B	Door	Jamb-Lft		Metal		0.25 ± 0.11	NEG	-0.6 ± 4.8	2.6	22	—
105	2	Room B-226	B	Door	Header		Metal		0.18 ± 0.10	NEG	0.6 ± 7.1	2.5	22	—
106	2	Room B-226		Ceiling	Header		Plaster		0.12 ± 0.21	NEG	-1.3 ± 2.6	6.6	22	—
107	2	Room B-226		Ceiling	Rad. Cover*		Metal		0.01 ± 0.07	NEG	0.1 ± 5.5	1.6	22	—
108	2	Room B-226		Ceiling	DC Grid*		Metal		0.03 ± 0.16	NEG	-1.4 ± 2.5	3.1	21	—

Room B-225

Site: V.A.M.C. Date: 01/08/97

Ranges (NEG<INC<POS): 0.0<1.00<1.00 Times: minL = 5 Ssec minK = 60 Ssec

XLNo	Fir	Room	Side	Structure	Feature	Cond.	Substr.	P.C. Sample	PbL(mg/cm ²)	RES	PbK	DI	Ssec	Final Result
109	2	Room B-225		Wall-A	Wall-Upr		Plaster		0.11 ± 0.07	NEG	-2.0 ± 3.0	1.9	22	—
110	2	Room B-225		Wall-B	Midle Wall		Plaster		0.08 ± 0.06	NEG	-1.8 ± 3.0	1.7	22	—
111	2	Room B-225		Wall-C	Wall-Lwr		Plaster		0.08 ± 0.08	NEG	-1.8 ± 3.0	2.1	22	—
112	2	Room B-225		Wall-C	Wall Rgstr		Metal		0.10 ± 0.07	NEG	-0.2 ± 5.7	2.0	22	—
113	2	Room B-225	A	Door	Door		Wood		0.01 ± 0.05	NEG	-0.6 ± 2.4	1.0	21	—
114	2	Room B-225	B	Door	Door		Wood		0.00 ± 0.01	NEG	-1.2 ± 2.3	1.0	21	—
115	2	Room B-225	C	Door	Door		Wood		0.00 ± 0.00	NEG	-1.0 ± 2.3	1.0	21	—
116	2	Room B-225	A	Door	Casing-Rht		Metal		0.22 ± 0.12	NEG	-1.5 ± 2.7	2.8	22	—
117	2	Room B-225	A	Door	Casing-Rht		Metal		0.24 ± 0.13	NEG	2.7 ± 12.5	2.4	16	—
118	2	Room B-225	A	Door	Casing-Rht		Metal		0.23 ± 0.09	NEG	0.6 ± 5.9	2.5	30	—
119	2	Room B-225	B	Door	Header		Metal		0.26 ± 0.12	NEG	-0.6 ± 4.3	2.8	23	—
120	2	Room B-225		Ceiling			Plaster		0.07 ± 0.13	NEG	-1.1 ± 2.6	2.8	22	—
121	2	Room B-225		Ceiling	Rad. Cover*		Metal		0.01 ± 0.01	NEG	0.4 ± 5.8	1.0	22	—

Room B-223

Site: V.A.M.C. Date: 01/08/97

Ranges (NEG<INC<POS): 0.0<1.00<1.00 Times: minL = 5 Ssec minK = 60 Ssec

XLNo	Fir	Room	Side	Structure	Feature	Cond.	Substr.	P.C. Sample	PbL(mg/cm ²)	RES	PbK	DI	Ssec	Final Result
135	2	Room B-223		Wall-B	Wall-Up		Plaster		0.08 ± 0.06	NEG	-0.7 ± 4.7	1.8	22	—
136	2	Room B-223		Wall-C	Middle Wall		Plaster		0.26 ± 0.28	NEG	-1.5 ± 2.9	5.6	22	—
137	2	Room B-223		Wall-D	Wall-Lwr		Plaster		0.17 ± 0.14	NEG	-1.2 ± 2.6	3.3	22	—
138	2	Room B-223		Wall-C	Rad. Cover*		Metal		0.07 ± 0.11	NEG	0.3 ± 7.1	1.8	9	—
139	2	Room B-223	A	Door-1	Door		Wood		0.00 ± 0.00	NEG	-1.0 ± 2.3	1.0	22	—
140	2	Room B-223	B	Door-2	Door		Wood		0.00 ± 0.00	NEG	-0.8 ± 2.0	1.0	21	—
141	2	Room B-223	C	Door-1	Door		Wood		0.01 ± 0.07	NEG	-0.7 ± 1.9	1.0	21	—
142	2	Room B-223	B	Door-2	Casing-Lft		Metal		0.11 ± 0.10	NEG	0.1 ± 4.4	2.8	22	—
143	2	Room B-223	B	Door-1	Jamb-Lft		Metal		0.16 ± 0.14	NEG	-0.9 ± 3.4	3.5	22	—
144	2	Room B-223	B	Door-2	Header		Metal		0.14 ± 0.13	NEG	0.0 ± 5.1	3.3	22	—
145	2	Room B-223		Ceiling	Pan*		Metal		0.02 ± 0.16	NEG	-1.1 ± 3.8	2.8	10	—
146	2	Room B-223		Ceiling	Pan*		Metal		0.00 ± 0.03	NEG	-1.3 ± 2.4	1.0	22	—
147	2	Room B-223		Ceiling	DC Grid*		Metal		0.03 ± 0.16	NEG	-0.7 ± 3.4	3.1	21	—
148	2	Room B-223		Ceiling	Rad. Cover*		Metal		0.00 ± 0.01	NEG	-0.2 ± 4.4	1.0	21	—
149	2	Room B-223		Ceiling	Panel*		Metal		0.03 ± 0.03	NEG	-1.5 ± 2.9	1.2	22	—

Room B-222

Site: V.A.M.C. Date: 01/08/97

Ranges (NEG<INC<POS): 0.0<1.00<1.00 Times: minL = 5 Ssec minK = 60 Ssec

XLNo	Fir	Room	Side	Structure	Feature	Cond.	Substr.	P.C. Sample	PbL(mg/cm ²)	RES	PbK	DI	Ssec	Final Result
150	2	Room B-222		Wall-A	Wall-Up*		Plaster		0.29 ± 0.40	NEG	-2.7 ± 4.2	5.5	13	—
151	2	Room B-222		Wall-A	Wall-Up*		Plaster		0.10 ± 0.09	NEG	-1.0 ± 3.4	2.3	22	—
152	2	Room B-222		Wall-B	Middle Wall		Plaster		0.17 ± 0.13	NEG	-1.6 ± 3.1	3.2	22	—
153	2	Room B-222		Wall-C	Wall-Lwr		Plaster		0.06 ± 0.22	NEG	-0.6 ± 3.7	3.6	22	—
154	2	Room B-222		Wall-C	Rad. Cover*		Metal		0.05 ± 0.10	NEG	-2.1 ± 3.4	2.4	22	—
155	2	Room B-222	A	Door-1	Door		Wood		0.01 ± 0.00	NEG	-1.0 ± 2.8	1.0	21	—
156	2	Room B-222	B	Door-1	Door		Wood		0.01 ± 0.01	NEG	-0.7 ± 2.0	1.0	21	—
157	2	Room B-222	C	Door-1	Door		Wood		0.01 ± 0.03	NEG	-1.3 ± 2.4	1.0	22	—
158	2	Room B-222	A	Door-1	Casing-Rht		Metal		0.08 ± 0.09	NEG	-1.0 ± 3.2	2.4	22	—
159	2	Room B-222	B	Door-1	Jamb-Lft		Metal		0.09 ± 0.06	NEG	-1.6 ± 2.9	1.8	22	—
160	2	Room B-222	B	Door-2	Header		Metal		0.08 ± 0.09	NEG	-0.8 ± 3.9	2.5	22	—
161	2	Room B-222		Ceiling	Pan*		Metal		0.00 ± 0.01	NEG	-1.1 ± 2.2	1.0	22	—
162	2	Room B-222		Ceiling	DC Grid*		Metal		0.00 ± 0.04	NEG	0.1 ± 4.5	1.0	21	—
163	2	Room B-222		Ceiling	Rad. Cover*		Metal		0.00 ± 0.01	NEG	-0.5 ± 4.5	1.0	22	—
164	2	Room B-222		Ceiling	Panel*		Metal		0.00 ± 0.01	NEG	-0.6 ± 4.3	1.0	22	—

Room B-221b
 Site: V.A.M.C. Date: 01/14/97
 Ranges (NEG<INC<POS): 0.0<1.00<1.00 Times: minL = 5 Ssec minK = 60 Ssec

XLNo	Flr	Room	Side	Structure	Feature	Cond.	Substr.	P.C. Sample	PbL(mg/cm ²)	RES	PbK	DI	Ssec	Final Result
405	2	Room B-221b		Wall-D	Panel*		Metal		0.15 ± 0.04	NEG	0.5 ± 6.2	1.2	22	—
406	2	Room B-221b		Wall-D	Panel*		Metal		0.15 ± 0.05	NEG	-0.4 ± 4.4	1.2	21	—
407	2	Room B-221b	A	Door	Door		Wood		0.03 ± 0.05	NEG	-0.1 ± 4.4	1.0	21	—
408	2	Room B-221b	A	Door	Door		Wood		0.00 ± 0.00	NEG	-0.9 ± 2.3	1.0	21	—
409	2	Room B-221b	C	Door	Door		Wood		0.01 ± 0.22	NEG	-1.0 ± 2.3	1.4	21	—
410	2	Room B-221b	A	Door	Header		Metal		0.04 ± 0.01	NEG	0.5 ± 6.9	1.0	22	—
411	2	Room B-221b	B	Door	Casing-Rht		Metal		0.16 ± 0.08	NEG	-1.1 ± 3.4	2.2	22	—
412	2	Room B-221b	B	Door	Casing-Lft		Metal		0.13 ± 0.10	NEG	-0.5 ± 4.5	2.7	22	—

Room B-221

Site: V.A.M.C. Date: 01/14/97

Ranges (NEG<INC<POS): 0.0<1.00<1.00 Times: minL = 5 Ssec minK = 60 Ssec

XLNo	Fir	Room	Side	Structure	Feature	Cond.	Substr.	P.C. Sample	PbL(mg/cm ²)	RES	PbK	DI	Ssec	Final Result
405	2	Room B-221		Wall-D	Panel*		Metal		0.15 ± 0.04	NEG	0.5 ± 6.2	1.2	22	—
406	2	Room B-221		Wall-D	Panel*		Metal		0.15 ± 0.05	NEG	-0.4 ± 4.4	1.2	21	—
407	2	Room B-221	A	Door	Door		Wood		0.03 ± 0.05	NEG	-0.1 ± 4.4	1.0	21	—
408	2	Room B-221	A	Door	Door		Wood		0.00 ± 0.00	NEG	-0.9 ± 2.3	1.0	21	—
409	2	Room B-221	C	Door	Door		Wood		0.01 ± 0.22	NEG	-1.0 ± 2.3	1.4	21	—
410	2	Room B-221	A	Door	Header		Metal		0.04 ± 0.01	NEG	0.5 ± 6.9	1.0	22	—
411	2	Room B-221	B	Door	Casing-Rht		Metal		0.16 ± 0.08	NEG	-1.1 ± 3.4	2.2	22	—
412	2	Room B-221	B	Door	Casing-Lft		Metal		0.13 ± 0.10	NEG	-0.5 ± 4.5	2.7	22	—

Room B-220

Site: V.A.M.C. Date: 01/09/97

Ranges (NEG<INC<POS): 0.0<1.00<1.00 Times: minL = 7 Ssec minK = 60 Ssec

XLNo	Fir	Room	Side	Structure	Feature	Cond.	Substr.	P.C. Sample	PbL(mg/cm ²)	RES	DI	Ssec	Final Result
339	2	Room B-220		Wall-A	Wall-Uptr	Solid	Plaster		0.12 ± 0.09	NEG	2.5	23	---
340	2	Room B-220		Wall-B	Middle Wall	Solid	Plaster		0.18 ± 0.13	NEG	3.0	22	---
341	2	Room B-220		Wall-C	Middle Wall	Solid	Plaster		0.13 ± 0.09	NEG	2.4	22	---
342	2	Room B-220		Ceiling	DC Grid*	Solid	Metal		0.01 ± 0.05	NEG	1.3	20	---
343	2	Room B-220		Wall-A	Wall Rgstr*	Solid	Metal		0.00 ± 0.00	NEG	1.0	21	---

Room B-216

Site: V.A.M.C. Date: 01/09/97

Ranges (NEG<INC<POS): 0.0<1.00<1.00 Times: minL = 7 Ssec minK = 60 Ssec

XLNo	Fir	Room	Side	Structure	Feature	Cond.	Substr.	P.C. Sample	PbL(mg/cm ²)	RES	DI	Ssec	Final Result
262	2	Room B-216		Wall-A	Wall-Up	Solid	Plaster		0.13 ± 0.15	NEG	3.5	22	---
263	2	Room B-216		Wall-B	Middle Wall	Solid	Plaster		0.19 ± 0.08	NEG	1.9	22	---
264	2	Room B-216		Wall-D	Middle Wall	Solid	Plaster		0.26 ± 0.12	NEG	2.7	22	---
265	2	Room B-216	A	Door	Door	Solid	Wood		0.00 ± 0.03	NEG	1.0	21	---
266	2	Room B-216	B	Door	Door	Solid	Wood		0.00 ± 0.00	NEG	1.0	21	---
267	2	Room B-216	C	Door	Door	Solid	Wood		0.01 ± 0.04	NEG	1.0	21	---
268	2	Room B-216	A	Door	Casing-Rht	Solid	Metal		0.15 ± 0.07	NEG	1.9	22	---
269	2	Room B-216	B	Door	Jamb-Rht	Solid	Metal		0.17 ± 0.19	NEG	4.4	22	---
270	2	Room B-216	B	Door	Header	Solid	Metal		0.16 ± 0.25	NEG	6.9	25	---
271	2	Room B-216		Ceiling		Solid	Plaster		0.14 ± 0.07	NEG	1.9	22	---
273	2	Room B-216		Wall	Diffuser*	Solid	Metal		0.20 ± 0.22	NEG	2.5	7	---
274	2	Room B-216		Wall	Diffuser*	Solid	Metal		0.16 ± 0.07	NEG	1.9	22	---
275	2	Room B-216		Ceiling	Panel*	Solid	Metal		0.16 ± 0.08	NEG	2.1	22	---

Room B-215

Site: V.A.M.C. Date: 01/09/97

Ranges (NEG<INC<POS): 0.0<1.00<1.00 Times: minL = 7 Ssec minK = 60 Ssec

XLNo	Flr	Room	Side	Structure	Feature	Cond.	Substr.	P.C. Sample	PbL(mg/cm ²)	RES	DI	Ssec	Final Result
290	2	Room B-215		Wall-B	Wall-Up	Solid	Plaster		0.10 ± 0.06	NEG	1.6	22	---
291	2	Room B-215		Wall-D	Middle Wall	Solid	Plaster		0.09 ± 0.07	NEG	2.0	22	---
292	2	Room B-215		Wall-A	Wall-Lwr	Solid	Plaster		0.19 ± 0.14	NEG	3.4	22	---
293	2	Room B-215		Wall-D	Radiator *	Solid	Metal		0.13 ± 0.11	NEG	3.0	22	---
294	2	Room B-215		Window	Mullion *	Solid	Wood		2.30 ± 1.26	POS	7.0	8	POS
295	2	Room B-215		Ceiling	DC Grid *	Solid	Metal		0.05 ± 0.06	NEG	1.9	21	---
296	2	Room B-215		Wall	Wall Rgstr *	Solid	Metal		0.01 ± 0.05	NEG	1.4	21	---
297	2	Room B-215		Cabinet-A	Door-Out	Solid			0.10 ± 0.08	NEG	2.3	22	---
298	2	Room B-215		Cabinet-A	Door-Out	Solid			0.09 ± 0.11	NEG	2.9	22	---
299	2	Room B-215		Window	Casing * Rht	Solid			>>5.0 ± ***	...	10.0	8	POS

Room B-213

Site: V.A.M.C. Date: 01/09/97

Ranges (NEG<INC<POS): 0.0<1.00<1.00 Times: minL = 7 Ssec minK = 60 Ssec

XLNo	Flr	Room	Side	Structure	Feature	Cond.	Substr.	P.C. Sample	PbL(mg/cm ²)	RES	DI	Ssec	Final Result
246	2	Room B-213		Wall-A	Wall-Upr	Solid	Plaster		0.14 ± 0.10	NEG	2.6	22	---
247	2	Room B-213		Wall-C	Middle Wall	Solid	Plaster		0.19 ± 0.11	NEG	2.8	22	---
248	2	Room B-213		Wall-D	Wall-Lwr	Solid	Plaster		0.24 ± 0.17	NEG	3.9	22	---
249	2	Room B-213		Wall-C	Radiator *	Solid	Metal		0.16 ± 0.13	NEG	3.2	22	---
250	2	Room B-213		Window	Casing *-Rht	Solid	Wood		2.45 ± ***	...	9.4	6	POS
251	2	Room B-213		Window	Casing *-Rht	Solid	Wood		2.13 ± ***	...	10.0	7	POS
252	2	Room B-213		Window	Mini Blind*	Solid	Metal		0.00 ± 0.01	NEG	1.0	22	---
253	2	Room B-213	A	Door	Door	Solid	Wood		0.01 ± 0.01	NEG	1.0	22	---
254	2	Room B-213	B	Door	Door	Solid	Wood		0.00 ± 0.00	NEG	1.0	21	---
255	2	Room B-213	C	Door	Door	Solid	Wood		0.00 ± 0.00	NEG	1.0	21	---
256	2	Room B-213	A	Door	Casing-Rht	Solid	Metal		0.14 ± 0.13	NEG	3.3	22	---
257	2	Room B-213	B	Door	Jamb-Rht	Solid	Metal		0.09 ± 0.11	NEG	2.9	24	---
258	2	Room B-213	B	Door	Header	Solid	Metal		0.08 ± 0.13	NEG	3.2	24	---
259	2	Room B-213		Ceiling		Solid	Plaster		0.09 ± 0.18	NEG	3.7	23	---
260	2	Room B-213		Ceiling	Panel*	Solid	Metal		0.00 ± 0.02	NEG	1.0	22	---
261	2	Room B-213		Wall-A	Wall Rgstr	Solid	Metal		0.01 ± 0.04	NEG	1.2	21	---

Room B-212

Site: V.A.M.C. Date: 01/09/97

Ranges (NEG<INC<POS): 0.0<1.00<1.00 Times: minL = 7 Ssec minK = 60 Ssec

XLNo	Fir	Room	Side	Structure	Feature	Cond.	Substr.	P.C. Sample	PbL(mg/cm ²)	RES	DI	Ssec	Final Result
233	2	Room B-212		Wall-B	Wall-Up	Solid	Plaster		0.16 ± 0.15	NEG	3.5	22	---
234	2	Room B-212		Wall-C	Middle Wall	Cracked	Plaster		0.06 ± 0.20	NEG	3.5	22	---
235	2	Room B-212		Wall-D	Wall-Lwr	Cracked	Plaster		0.19 ± 0.14	NEG	3.2	22	---
236	2	Room B-212		Wall-C	Radiator *	Cracked	Metal		0.13 ± 0.14	NEG	3.5	22	---
237	2	Room B-212	A	Door	Door	Solid	Wood		0.00 ± 0.11	NEG	1.0	21	---
238	2	Room B-212	B	Door	Door	Solid	Wood		0.00 ± 0.07	NEG	1.0	21	---
239	2	Room B-212	C	Door	Door	Solid	Wood		0.00 ± 0.00	NEG	1.0	21	---
240	2	Room B-212	A	Door	Casing-Lft	Solid	Metal		0.13 ± 0.11	NEG	2.9	22	---
241	2	Room B-212	B	Door	Jamb-Lft	Solid	Metal		0.07 ± 0.08	NEG	2.3	23	---
242	2	Room B-212	B	Door	Header	Solid	Metal		0.10 ± 0.12	NEG	3.0	22	---
243	2	Room B-212		Ceiling		Solid	Plaster		0.07 ± 0.11	NEG	2.8	23	---
244	2	Room B-212		Ceiling	Panel*	Solid	Metal		0.00 ± 0.02	NEG	1.0	22	---
245	2	Room B-212		Wall-A	Wall Rgstr	Solid	Metal		0.00 ± 0.00	NEG	1.0	21	---

Room B-211

Site: V.A.M.C. Date: 01/09/97

Ranges (NEG<INC<POS): 0.0<1.00<1.00 Times: minL = 7 Ssec minK = 60 Ssec

XLNo	Fir	Room	Side	Structure	Feature	Cond.	Substr.	P.C. Sample	PbL(mg/cm ²)	RES	DI	Ssec	Final Result
220	2	Room B-211		Wall-A	Wall-Uptr	Solid	Plaster		0.03 ± 0.12	NEG	2.3	22	---
221	2	Room B-211		Wall-C	Middle Wall	Solid	Plaster		0.14 ± 0.18	NEG	7.7	32	---
222	2	Room B-211		Wall-C	Middle Wall	Solid	Plaster		0.07 ± 0.25	NEG	4.1	22	---
223	2	Room B-211		Wall-C	Radiator *	Solid	Metal		0.17 ± 0.19	NEG	4.3	22	---
224	2	Room B-211		Wall-C	Wall Rgstr	Solid	Metal		0.00 ± 0.03	NEG	1.0	21	---
225	2	Room B-211	A	Door	Door	Solid	Wood		0.02 ± 0.18	NEG	2.7	21	---
226	2	Room B-211	B	Door	Door	Solid	Wood		0.00 ± 0.01	NEG	1.0	22	---
227	2	Room B-211	C	Door	Door	Solid	Wood		0.02 ± -0.01	NEG	5.1	24	---
228	2	Room B-211	A	Door	Jamb-Rht	Solid	Metal		0.00 ± 0.00	NEG	1.0	23	---
229	2	Room B-211	B	Door	Jamb-Rht	Solid	Metal		0.02 ± 0.11	NEG	2.3	22	---
230	2	Room B-211	B	Door	Header	Solid	Metal		0.13 ± ***	INC	10.0	61	NEG
231	2	Room B-211		Ceiling	Header	Solid	Plaster		0.16 ± 0.15	NEG	3.5	22	---
232	2	Room B-211		Wall	Wall Rgstr	Solid	Metal		0.13 ± 0.14	NEG	3.6	23	---

Room B-210

Site: V.A.M.C. Date: 01/09/97

Ranges (NEG<INC<POS): 0.0<1.00<1.00 Times: minL = 7 Ssec minK = 60 Ssec

XLNo	Fir	Room	Side	Structure	Feature	Cond.	Substr.	P.C. Sample	PbL(mg/cm ²)	RES	DI	Ssec	Final Result
206	2	Room B-210		Wall-A	Wall-Upr	Solid	Plaster		0.05 ± 0.14	NEG	2.9	22	---
208	2	Room B-210		Wall-C	Middle Wall	Solid	Plaster		0.12 ± 0.25	NEG	5.9	22	---
209	2	Room B-210		Wall-C	Radiator *	Solid	Metal		0.10 ± 0.11	NEG	2.8	22	---
210	2	Room B-210		Wall-C	Wall Rgstr*	Solid	Metal		0.00 ± 0.01	NEG	1.0	21	---
211	2	Room B-210	A	Door	Door	Solid	Wood		0.00 ± 0.01	NEG	1.0	21	---
212	2	Room B-210	B	Door	Door	Solid	Wood		0.00 ± 0.07	NEG	1.0	22	---
213	2	Room B-210	C	Door	Door	Solid	Wood		0.00 ± 0.00	NEG	1.0	21	---
214	2	Room B-210	A	Door	Casing-Rht	Solid	Metal		0.00 ± 0.00	NEG	1.0	22	---
215	2	Room B-210	B	Door	Jamb-Rht	Solid	Metal		0.01 ± 0.07	NEG	1.5	22	---
216	2	Room B-210	B	Door	Header	Solid	Metal		0.06 ± 0.13	NEG	6.4	22	---
217	2	Room B-210		Ceiling		Solid	Plaster		0.13 ± 0.16	NEG	3.7	23	---
218	2	Room B-210		Ceiling	Panel*	Solid	Metal		0.00 ± 0.07	NEG	1.0	22	---
219	2	Room B-210		Wall	Diffuser*	Solid	Metal		0.14 ± 0.23	NEG	4.9	22	---

Room B-209

Site: V.A.M.C. Date: 01/09/97

Ranges (NEG<INC<POS): 0.0<1.00<1.00 Times: minL = 7 Ssec minK = 60 Ssec

XLNo	Flr	Room	Side	Structure	Feature	Cond.	Substr.	P.C. Sample	PbL(mg/cm ²)	RES	DI	Ssec	Final Result
190	2	Room B-209		Wall-A	Midle Wall	Solid	Plaster		0.10 ± 0.22	NEG	4.2	22	---
191	2	Room B-209		Wall-C	Midle Wall	Solid	Plaster		0.02 ± 0.07	NEG	1.7	30	---
192	2	Room B-209		Wall-D	Midle Wall	Solid	Plaster		0.06 ± 0.13	NEG	3.1	26	---
193	2	Room B-209	A	Door	Door	Solid	Wood		0.01 ± 0.18	NEG	1.0	11	---
194	2	Room B-209	A	Door	Door	Solid	Wood		0.01 ± 0.07	NEG	1.0	21	---
195	2	Room B-209	B	Door	Door	Solid	Wood		0.01 ± 0.08	NEG	1.1	25	---
196	2	Room B-209	C	Door	Door	Solid	Wood		0.01 ± ***	...	10.0	29	NEG
197	2	Room B-209	C	Door	Casing-Lft	Solid	Metal		0.26 ± 0.14	NEG	3.7	27	---
198	2	Room B-209	B	Door	Jamb-Rht	Solid	Metal		0.06 ± 0.06	NEG	1.8	22	---
199	2	Room B-209	B	Door	Header	Solid	Metal		0.15 ± 0.16	NEG	3.9	22	---

Room A 235

Site: V.A.M.C. Date: 01/10/97

Ranges (NEG<INC<POS): 0.0<1.00<1.00 Times: minL = 5 Ssec minK = 60 Ssec

XLNo	Flr	Room	Side	Structure	Feature	Cond.	Substr.	P.C. Sample	PbL(mg/cm ²)	RBS	PbK	DI	Ssec	Final Result
354	2	Room A-235		Wall-A	Wall-Uptr		Plaster		0.09 ± 0.11	NEG	1.9 ± 6.0	4.4	61	—
355	2	Room A-235		Wall-B	Midle Wall		Plaster		0.01 ± 0.06	NEG	1.0 ± 7.4	1.2	22	—
356	2	Room A-235		Wall-C	Midle Wall		Plaster		0.06 ± 0.09	NEG	1.8 ± 5.7	3.8	61	—
357	2	Room A-235	A	Door-1	Door		Wood		0.01 ± 0.14	NEG	2.7 ± 9.3	1.6	31	—
358	2	Room A-235	B	Door-1	Door		Wood		0.01 ± 0.23	NEG	2.8 ± 11.5	1.6	21	—
359	2	Room A-235	A	Door-2	Door		Wood		0.04 ± 0.17	NEG	0.5 ± 4.8	4.0	33	—
360	2	Room A-235	A	Door-1	Casing-Rht		Metal		0.02 ± 0.03	NEG	2.9 ± 10.7	1.3	25	—
361	2	Room A-235	B	Door-1	Jamb-Rht		Metal		0.02 ± 0.06	NEG	0.7 ± 6.7	1.7	22	—
362	2	Room A-235	A	Door-1	Header		Metal		0.04 ± 0.06	NEG	-0.6 ± 4.3	1.9	22	—
363	2	Room A-235	A	Wall-A	Panel*		Metal		0.02 ± 0.01	NEG	-0.6 ± 3.9	1.0	21	—
364	2	Room A-235	A	Wall-A	Wall Rgstr*		Metal		0.01 ± 0.03	NEG	0.7 ± 6.4	1.0	21	—

Room A-245

Site: V.A.M.C. Date: 01/14/97

Ranges (NEG<INC<POS); 0.0<1.00<1.00 Times: minL = 5 Ssec minK = 60 Ssec

XLNo	Fir	Room	Side	Structure	Feature	Cond.	Substr.	P.C. Sample	PbL(mg/cm ²)	RES	PbK	DI	Ssec	Final Result
249	2	Room A-245	A	Door	Door		Wood		0.00 ± 0.09	NEG	-0.9 ± 2.3	1.0	21	—
250	2	Room A-245	B	Door	Door		Wood		0.00 ± 0.00	NEG	-1.0 ± 2.1	1.0	21	—
251	2	Room A-245	C	Door	Door		Wood		0.00 ± 0.00	NEG	-1.3 ± 2.0	1.0	27	—
252	2	Room A-245	A	Door	Casing-Rht		Metal		0.03 ± 0.04	NEG	-0.9 ± 5.6	1.2	19	—
253	2	Room A-245	B	Door	Jamb-Rht		Metal		0.02 ± 0.05	NEG	-0.6 ± 4.2	1.5	22	—
254	2	Room A-245	B	Door	Header		Metal		0.03 ± 0.08	NEG	-0.5 ± 5.1	2.1	22	—
255	2	Room A-245		Wall	Rad. Cover*		Metal		0.06 ± 0.03	NEG	-0.3 ± 4.5	1.2	22	—
256	2	Room A-245		Ceiling	DC Grid*		Metal		0.23 ± ***	...	0.8 ± 4.8	10.0	45	NEG
257	2	Room A-245		Ceiling	DC Grid*		Metal		0.36 ± ***	...	0.2 ± 3.4	10.0	51	NEG
258	2	Room A-245		Ceiling	DC Grid*		Metal		0.28 ± ***	INC	-0.2 ± 2.6	10.0	62	NEG

TAB 4
VA EQUIPMENT LIST

9/14/2011

**MODERNIZATION OF KITCHEN AND CANTEEN
VA - MEDICAL CENTER
ANN ARBOR, MICHIGAN
JOB NO. 03192**

Equipment List

Kitchen	Item	QTY	Description	Owner Provided	Contractor Provided	Warranty
	1	1 lot	Storage Shelving		x	1 year
	2	1	Walk-in Refrigerator		x	1 year
	3	1 lot	Remote Refrigeration Systems		x	1 year
	4	1 lot	Portable Pan Racks		x	1 year
	5	1 lot	Portable Refrigerator Shelving		x	1 year
	6	1 lot	Portable Refrigerator Shelving		x	1 year
	7	1 lot	Portable Refrigerator Shelving		x	1 year
	8	1 lot	Portable Refrigerator Shelving		x	1 year
	9	2	Roll-in Blast Chillers - Existing	x		
	10	1	Walk-in Freezer		x	1 year
	11	1 lot	Retherm Tray Delivery Carts - Existing	x		
	12	1 lot	Tray Transport Racks - Existing	x		
	13	1	Two Section Reach-in Freezer		x	1 year
	14	2	St. St. Hand Sink		x	1 year
	15	1	3 H.P. Disposer W/Pre-Rinse		x	1 year
	16	1 lot	St. St. Wall Paneling		x	1 year
	17	1	St. St. Three Compartment Sinks		x	1 year
	18	1 lot	Storage Shelving		x	1 year
	19	1	Portable Pan Rack		x	1 year
	20	1	Hose Reel Assembly		x	1 year
	21	1	Wall Mounted Mop Rack		x	1 year
	22	2	St. St. Wall Panels		x	1 year
	23	1 lot	Chemical/Linen Storage Shelving		x	1 year
	24	1	St. St. Hand Sink		x	1 year
	25	1 lot	St. St. Wall Paneling		x	1 year
	26	1	3 H.P. Disposer W/Pre-Rinse		x	1 year
	27	1 lot	St. St. Soiled & Clean Dishtables W/ Power Soak		x	1 year
	28	2	St. St. Exhaust Ducts		x	1 year
	29	1	Conveyor Dishwasher W/ Booster Heater		x	1 year
	30	1	Soap & Rinse Dispenser - By Vender "NIC"			
	31	1 lot	Wire Wall Shelving		x	1 year
	32	1	Wall Mounted Washdown Station		x	1 year
	33	1	St. St. Hand Sink		x	1 year
	34	1	Coffee Maker		x	1 year
	35	1 lot	Cup & Glass Racks - By Owner "NIC"	x		
	36	1	St. St. Work Counter W/ Sink		x	1 year
	37	1	Iced Tea Maker		x	1 year
	38	1	Ice Bin		x	1 year
	39	1	Remote Soda System - By vender "NIC"			
	40	1 lot	Storage Shelving		x	1 year
	41		not used			
	42	1	St. St. Work Table		x	1 year
	43	1	Two Section Roll-in Refrigerator		x	1 year
	44	8	Portable Pan Racks		x	1 year
	45	2	Portable Dish Cart - Existing	x		
	46	4	Portable Heated Cabinets - Existing	x		
	47	2	Portable Cold Food Table - Existing	x		
	48	4	Wire Dish Storage Racks - Existing	x		
	49	4	St. St. Work Tables - Existing	x		
	50	2	Wire Shelving Unit - Existing			
	51	2	St. St. Hand Sinks		x	1 year
	52	1	St. St. Work Table W/Sink		x	1 year
	53	1	Two Section Roll-in Refrigerator		x	1 year
	54	1	St. St. Hand Sink		x	1 year
	55	1 lot	St. St. Corner Guards		x	1 year
	56	1	St. St. Work Table W/Sink		x	1 year
	57	1 lot	St. St. Wall Paneling		x	1 year
	58	1	St. St. Hand Sink		x	1 year
	59	1	St. St. Work Table		x	1 year
	60		not used			
	61	1	St. St. Hand Sink		x	1 year
	62	1	St. St. Work Table W/Sink		x	1 year
	63	1	St. St. Exhaust Hood		x	1 year
	64	1	Fire Suppression System		x	1 year
	65	1 lot	St. St. Wall Paneling		x	1 year
	66	1	Single Section Roll-in Refrigerator		x	1 year
	67	1	St. St. Hand Sink		x	1 year
	68	1	Two Section Reach-in Refrigerator		x	1 year
	69		not used			
	70	1	St. St. Portable Slicer Table		x	1 year

71	1	Automatic Slicer		x	1 year
72	1	St. St. Two Compartment Sinks		x	1 year
73	1 lot	St. St. Wall Paneling		x	1 year
74	1	St. St. Work Table W/Sink		x	1 year
75		St. St. Work Table W/Sink		x	1 year
76	1	60 Gallon Tilt Kettle		x	1 year
77		St. St. Floor Drainer		x	1 year
78		not used			
79	1	St. St. Floor Drainer		x	1 year
80	2	40 Qt. Tilting Kettles W/ Stand		x	1 year
81	1	Steamer		x	1 year
82	1	St. St. Exhaust Hoods		x	1 year
83	1	Fire Suppression System		x	1 year
84	1	Utility Distribution System		x	1 year
85	1	Combi-Oven		x	1 year
86	1	Combi-Oven		x	1 year
87	1	Combi-Oven		x	1 year
88	1	Double-Deck Convection Oven		x	1 year
89		not used			
90	1	St. St. Exhaust Hood		x	1 year
91	1	Fire Suppression System		x	1 year
92	1 lot	St. St. Wall Paneling		x	1 year
93	3	Cash Register/P.O.'s Systems "NIC"	x		
94	1	St. St. Island Exhaust Hood		x	1 year
95	1	Fire Suppression System		x	1 year
96	1	Walk-in Refrigerator		x	1 year
97	1	Remote Refrigeration System		x	1 year
98	2	Roll-In Blast Chillers W/ Portable Racks		x	1 year
99	2	Remote Refrigeration Systems		x	1 year
100	2	St. St. Work Tables		x	1 year
101	1	St. St. Two Compartment Sinks		x	1 year
102	1	St. St. Work Tables		x	1 year
103	1	Tilt Braising Pan		x	1 year
104	1	St. St. Exhaust Hood		x	1 year
105	1	Fire Suppression System		x	1 year
106	1 lot	St. St. Wall Paneling		x	1 year
107	1	St. St. Work Table W/Sink		x	1 year
108	1	St. St. Work Table W/Sink		x	1 year
109	1	Reach-In Refrigerator		x	1 year
110	1 lot	Storage Shelving		x	1 year
111	1	St. St. Work Table W/Sink		x	1 year
112	1 lot	Field Erection Labor (1 thru 111)		x	1 year
113	1 lot	Field Erection Labor - Temporary Kitchen		x	1 year
114	1	St. St. Exhaust Hood		x	1 year
115	1	Fire Suppression System		x	1 year
116	1 lot	St. St. Wall Paneling		x	1 year

Canteen Supply and Medical Center Contractor Install - Items

V6	3	Condiment Stands	
V7	1	Microwave Stand	
V9	10	Menu Boards	
V13	2	Register Stands	
V14	1	Register Stand	
V17	4	Tray Dispensers	
V21	2	Microwave Ovens	
B1	1	Beverage Counter	
B2	1	Beverage Counter	
B6	8	Cup Dispensers, Cold	
B7	6	Cup Dispensers, Hot	
B8	2	Beverage/Ice Dispensers - By Coke	
B8A	1	Ice Machine, Undercounter	
B9	2	Cappuccino Dispensers	
B12	1	Juice Dispensers	
B17	2	Coffee Brewers	
CC1	1	Country Cooking	
CC14	2	1 Section Warmer, Pass - Thru	
CR2	1	Rotisserie, Countertop Electric	
CR3	1	Express Profit Center Merchandiser	
FA1	1	Fifth Avenue Deli	
FA3	2	Bread Racks	
FA4E	1	Existing Deli Oven W/ Proofer	
FA7	1	Refrigerated Work Table	
FA8E	1	Existing Food Prep Table	
FA9E	1	Existing Tornado Oven	
FA10	1	Toaster, Pop-Up	
FC1E	1	Existing Fresh Choice Bristo Counter	
FC5	1	Dump Table W/ Heat Lamp	
FC8E	1	Existing Food Prep Table	
FC11	1	Griddle	
FC14	2	Fryers	
FC15	3	Induction Range, Countertop	

	IC1	1	Ice Cream Cabinet			
	K3	1	Combitherm Oven W/ Stand			
	K5	1	Double-Deck Convection Oven			
	K14E	1	Existing Two Section Display Refrigerator			
	K15	1	Two Section Display Refrigerator			
	K15E	1	Existing Two Section Display Refrigerator			
	K16	1	One Section Refrigerator			
	K17E	1	Existing Two Section Freezer			
	K18E	3	Existing Two Section Refrigerator			
	K20	1	One Section Roll-In Refrigerator			
	K21	1	One Section Roll-In Freezer			
	K38	1	Work Table			
	K39	1	Work Table			
	K40	1	Work Table W/ Drawer			
	K41	2	Work Table W/ Drawer			
	K50	1	Toaster			
	M2E	1	Existing Merchandiser, Hot			
	MC1	1	Merchandiser Counter			
	P1	1	Existing Merchandiser, Non-Refrigerated			
	PB2	1	Pizza Counter			
	PB5	1	Pizza Display Warmer			
	PB15	1	Pizza Oven			
	PB15E	1	Existing Pizza Oven W/ Stand			
	PB16	1	Soup Station			
	SB1	1	Salad Counter			
	SB5E	2	Existing Salad/Deli Case			
	SS1	1	Saute Station W/ Induction Cookers			
	D6	10	27" x 24" Table W/ 1 Chair			
	D7	14	47" x 30" Table W/ 2 Chairs			
	D8	12	36" Round Table W/ 4 Chairs			
	D9	5	42" Round Table W/ 4 Chairs			
	D10	4	47" x 30" Table W/ 1 Chair, Handicap			
	D11	4	36" Round Table W/ 3 Chairs, Handicap			
	D12	2	42" Round Table W/ 3 Chairs, Handicap			
	D18	8	Side Table			
	D19	16	Amico Lounge Chairs			
	D21	8	Trash Receptacle (Single)			
4th Floor Mech. Room				Unit No.	Owner Provided	Contractor provided
				1W-AH-8		x
				1W-AH-16	x	
				1W-AH-17		x
5th Floor Mech. Room				Unit No.	Owner Provided	Contractor provided
				1W-AH-18		x
Roof Top Units				Unit No.	Owner Provided	Contractor provided
				1W-AH-19		x
				1W-MU-01		x
				EF-1		x
				EF-2		x
				EF-3		x
				EF-4		x
				EF-5		x
				EF-6		x
				EF-7		x
				EF-8		x
				EF-9		x
				EF-10		x
Canteen Break Rm				QTY	Item	Owner Provided
				1	Refrigerator	x
Vending				QTY	Item	Owner Provided
				8	Vending Machines	x
						Contractor provided
						Warranty

TAB 5
VA PROJECT PHASING

**MODERNIZATION OF KITCHEN AND CANTEEN
VA - MEDICAL CENTER
ANN ARBOR, MICHIGAN
JOB NO. 03192**

Detailed Mile Stone Schedule

Pre-purchase long-lead equipment in construction phases	Duration Approx. Work Days	Potential Off Hours Work
1) Air handling units	60	
2) Kitchen equipment	50	
Preconstruction meeting between; Owner, User, A-E, CM and Subs prior to the start of each construction phase.	Duration Approx. Work Days	Potential Off Hours Work
1) Has the submittal procedure been completed for this phase? 2) Identify effected areas, personnel, services, utilities and functions. 3) How will the listed items be affected. 4) Are there any Services/Functions to be temporarily maintained? 5) Where, how and when will; work begin, construction separation partitions be installed, utilities shut-off/rerouted/supplemented? 6) Infection control procedures and systems. 7) Utilities required for construction. 8) Access paths for construction materials, personnel and rubbish, from property line to point of use/origin. 9) Noise, vibration, dust and fume creating activities and controls if needed. 10) Off-hours work. 11) Required signage. 12) Hazardous waste and environmental remediation complete? 13) Construction personnel access and use of existing facilities. 14) Schedule weekly Owner/Architect/Engineer/Contractor meeting.		
Equipment and personnel relocations by Owner	Duration Approx. Work Days	Potential Off Hours Work
1) Research laboratory.		
2) Residence sleeping quarters.		
3) Social worker office.		
Phase 1A-1B	Duration Approx. Work Days	Potential Off Hours Work
Demolition:		
1) Evacuate space.	5	
2) Install temporary construction partitions and signage.	2	Yes
3) Institute inflection control systems and methods.	2	Yes
4) Confirm environmental hazard testing and report.	2	Yes
5) Abatement of hazardous materials.	15	Yes
6) Off-hours abatement of hazardous materials on adjacent floors.	5	Yes
7) Re-feed services / utilities as needed to existing areas disrupted by construction activities.	5	Yes
8) Installation of temporary utilities needed for construction.	3	Yes
9) Confirmation of in-wall utilities.	1	
10) Remove and salvage for relocation; paging speakers, card readers and cameras.	2	
11) Demolish ceiling supported M/E devices.	2	
12) Demolish ceilings.	2	
13) Coordinate shutdown and demolition of above ceiling electrical auxiliary systems.	2	
14) Coordinate shutdown and demolition of above ceiling electrical lighting systems.	3	
15) Coordinate shutdown and demolition of above ceiling electrical power systems.	2	
16) Coordinate shutdown, capping and demolition of above ceiling sprinkler system.	3	Yes
17) Coordinate shutdown, capping and demolition of above ceiling plumbing systems.	3	Yes

18) Coordinate shutdown, capping and demolition of above ceiling steam heating system.	3	Yes
19) Coordinate shutdown, capping and demolition of above ceiling HVAC system.	4	Yes
20) Demolish millwork, sinks and countertops.	2	
21) Demolish steam heating units and window air conditioners.	4	
22) Demolish doors.	1	
23) Demolish partitions.	1	
24) Demolish flooring.	2	
25) Patch abandoned floor and wall penetrations.	1	
Construction:		
1) Layout partition walls and install tracks.	1	
2) Temporary exterior kitchen exhaust ductwork and fan on roof.	10	
3) Frame, board and finish wall behind temporary kitchen exhaust.	2	
4) Install temporary kitchen exhaust hood.	2	
5) Above ceiling gravity plumbing lines.	5	
6) Above ceiling HVAC ductwork.	7	
7) Connect to existing unit 1W-AH-16 for outside air, reuse existing ductwork when possible to provide make-up air and exhaust.	4	Yes
8) Above ceiling sprinkler piping and kitchen hood suppression system.	5	Yes
9) Above ceiling pressure plumbing lines.	4	Yes
10) Above ceiling temporary 1 1/2" natural gas line for temporary kitchen.	2	Yes
11) Above ceiling electrical power.	5	
12) Above ceiling lighting.	5	
13) Above ceiling electrical auxiliary systems.	5	
14) Set door frames.	1	
15) Stud partition walls install in-wall back boxes, blocking and reinforcement.	1	
16) M/E rough-in for partitions.	2	
17) Mechanical pressure tests.	1	
18) Mechanical insulation.	3	
19) Inspections.	1	
20) Board partitions.	1	
21) Drywall finish.	2	
22) Wall finishes.	2	
23) Trim wall mounted devices.	1	
24) Ceiling grid.	2	
25) Ceiling supported devices.	2	
26) Countertops	2	
27) Toilet room fixtures and accessories.	2	
28) Floor finishes.	4	
29) Toilet room partitions.	1	
30) Kitchen equipment.	15	
31) Doors, hardware and glass.	2	
32) Above ceiling inspection.	1	
33) Ceiling tiles.	2	
34) Test and balance	2	
35) Commissioning	1	
36) Signage	1	
37) Punchlist	5	
38) Owners training.	1	
39) Final inspections.	1	
40) Owners furniture and equipment.	2	
41) Remove temporary construction.	1	
42) Phone and data activation.	1	
43) Occupy	1	
Phase 1C-2A	Duration Approx. Work Days	Potential Off Hours Work
Demolition:		
1) Evacuate space.	5	
2) Install temporary construction partitions and signage.	2	Yes
3) Institute inflection control systems and methods.	1	
4) Confirm environmental hazard testing and report.	2	Yes
5) Abatement of hazardous materials.	15	Yes

6) Off-hours abatement of hazardous materials on adjacent floors.	5	Yes
7) Re-feed services / utilities as needed to existing areas disrupted by construction activities, includes dish wash area.	10	Yes
8) Installation of temporary utilities needed for construction.	3	Yes
9) Confirmation of in-wall utilities.	1	
10) Coordinate shutdown, capping and demolition of natural gas piping.	2	Yes
11) Demolish / salvage existing kitchen equipment.	7	
12) Remove and salvage for relocation; paging speakers, card readers and cameras.	2	
13) Demolish ceiling supported M/E devices.	3	
14) Demolish ceilings.	3	
15) Coordinate shutdown and demolition of above ceiling electrical auxiliary systems.	2	
16) Coordinate shutdown and demolition of above ceiling electrical lighting systems.	3	
17) Coordinate shutdown and demolition of above ceiling electrical power systems.	3	
18) Coordinate shutdown, capping and demolition of above ceiling sprinkler system.	3	Yes
19) Coordinate shutdown, capping and demolition of above ceiling plumbing systems, includes floor drains and sanitary piping in 2nd floor ceiling.	5	Yes
20) Coordinate shutdown, capping and demolition of above ceiling steam heating system.	3	Yes
21) Coordinate shutdown, capping and demolition of above ceiling HVAC system.	7	Yes
22) Coordinate shutdown, capping and demolition of kitchen exhaust ducts and hoods.	5	Yes
23) Demolish grease hood exhaust fan on roof.	1	
24) Demolish kitchen make-up air units.	5	
25) Demolish all mechanical ventilation units.	5	
26) Demolish steam heating units and window air conditioners.	5	
27) Demolish doors.	2	
28) Demolish partitions.	3	
29) Demolish flooring, includes quarry tile, waterproofing and setting bed.	7	Yes
30) Patch abandoned floor and wall penetrations.	1	
31) Demolish roofing, existing curbs and equipment supports on Level 4.	5	

Construction:

	Duration Approx. Work Days	Potential Off Hours Work
1) Install curbs for roof top mechanical units.	5	
2) Install new roof on Level 4.	5	
3) Install roof top mechanical units on Level 4.	7	
4) Layout partition walls and install tracks.	3	
5) Reinforcement of structural floor slab in freezer/cooler areas.	5	Yes
6) Waterproof / place setting bed for hard tile floor.	5	
7) Install kitchen exhaust hood.	5	
8) Above ceiling gravity plumbing lines.	5	
9) Install kitchen exhaust duct.	10	
10) Above ceiling HVAC ductwork.	7	Yes
11) Above ceiling sprinkler piping and kitchen hood suppression system.	5	Yes
12) Above ceiling pressure plumbing lines.	5	Yes
13) Above ceiling natural gas main for kitchen.	3	
14) Above ceiling electrical power.	5	
15) Above ceiling lighting.	5	
16) Above ceiling electrical auxiliary systems.	5	
17) Install cart wash equipment.	5	
18) Install freezers / coolers.	10	
19) Set door frames.	2	
20) Stud partition walls, install in-wall back boxes, blocking and reinforcement.	3	
21) Stub services from 2nd floor ceiling space through 3rd floor slab.	3	Yes
22) M/E rough-in for partitions.	3	
23) Mechanical pressure tests.	1	
24) Mechanical insulation.	3	
25) Inspections.	1	
26) Board partitions.	2	
27) Drywall finish.	3	
28) Wall finishes.	2	
29) Trim wall mounted devices.	1	
30) Ceiling grid.	2	

- 31) Ceiling supported devices.
- 32) Toilet room fixtures and accessories.
- 33) Floor finishes.
- 34) Toilet room partitions.
- 35) Kitchen equipment.
- 36) Doors, hardware and glass.
- 37) Above ceiling inspection.
- 38) Gypsum board ceilings.
- 39) Ceiling tiles.
- 40) Test and balance
- 41) Commissioning
- 42) Signage
- 43) Punchlist
- 44) Owners training.
- 45) Final inspections.
- 46) Owners furniture and equipment.
- 47) Remove temporary construction.
- 48) Phone and data activation.
- 49) Occupy

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Phase 2B-2C	Duration Approx. Work Days	Potential Off Hours Work
Demolition:		
1) Evacuate space.	2	
2) Install temporary construction partitions and signage.	3	Yes
3) Institute infection control systems and methods.	1	Yes
4) Confirm environmental hazard testing and report.	2	Yes
5) Abatement of hazardous materials.	15	Yes
6) Off-hours abatement of hazardous materials on adjacent floors.	5	Yes
7) Re-feed services / utilities as needed to existing areas disrupted by construction activities.	5	Yes
8) Installation of temporary utilities needed for construction.	3	Yes
9) Confirmation of in-wall utilities.	1	
10) Coordinate shutdown of 1W-AH-16 and demolish along with ductwork. Coordinate shutdown, capping and demolition of temporary gas main.	15	Yes
11) Demolish temporary kitchen exhaust ductwork and roof top fan.	7	
12) Remove and salvage for relocation; paging speakers, card readers and cameras.	3	
13) Demolish ceiling supported M/E devices.	3	
14) Demolish ceilings.	2	
15) Coordinate shutdown and demolition of above ceiling electrical auxiliary systems.	2	
16) Coordinate shutdown and demolition of above ceiling electrical lighting systems.	3	
17) Coordinate shutdown and demolition of above ceiling electrical power systems.	3	
18) Coordinate shutdown, capping and demolition of above ceiling sprinkler system and hood suppression system.	3	Yes
19) Coordinate shutdown, capping and demolition of above ceiling plumbing systems.	3	Yes
20) Coordinate shutdown, capping and demolition of above ceiling steam heating system.	2	Yes
21) Coordinate shutdown, capping and demolition of above ceiling HVAC system.	3	Yes
22) Coordinate shutdown, capping and demolition of 2nd floor ceiling plumbing.	3	Yes
23) Demolish kitchen hood.	1	
24) Demolish doors.	1	
25) Demolish toilet room fixtures, partitions and accessories.	1	
26) Demolish / salvage dish washing equipment.	5	
27) Demolish partitions.	2	
28) Demolish flooring, includes quarry tile, 2" setting bed and waterproofing.	7	
29) Patch abandoned floor and wall penetrations.	1	
	Duration Approx. Work Days	Potential Off Hours Work
Construction:		
1) Layout partition walls and install tracks.	2	
2) Above ceiling gravity plumbing lines.	3	Yes

3) Above ceiling HVAC ductwork.	5	Yes
4) Above ceiling sprinkler piping.	5	Yes
5) Above ceiling pressure plumbing lines.	5	Yes
6) Above ceiling electrical power.	5	
7) Above ceiling lighting.	5	
8) Above ceiling electrical auxiliary systems.	5	
9) Set door frames.	1	
10) Stud partition walls install in-wall back boxes, blocking and reinforcement.	2	
11) M/E rough-in for partitions.	2	
12) Mechanical pressure tests.	1	
13) Mechanical insulation.	3	
14) Inspections.	1	
15) Board partitions.	2	
16) Drywall finish.	3	
17) Wall finishes.	2	
18) Trim wall mounted devices.	1	
19) Ceiling grid.	3	
20) Ceiling supported devices.	3	
21) Countertops	2	
22) Floor finishes.	5	
23) Canteen equipment.	4	
24) Doors, hardware and glass.	1	
25) Above ceiling inspection.	1	
26) Ceiling tiles.	2	
27) Test and balance	1	
28) Commissioning	1	
29) Signage	1	
30) Punchlist	5	
31) Owners training.	1	
32) Final inspections.	1	
33) Owners furniture and equipment.	3	
34) Remove temporary construction, leaving temporary walls in existing dish washing area.	1	Yes
35) Phone and data activation.	1	
36) Occupy	1	

Phase 2D-3A	Duration Approx. Work Days	Potential Off Hours Work
Demolition:		
1) Evacuate space.	5	
2) Install temporary construction partitions and signage.	3	
3) Institute infection control systems and methods.	1	
4) Confirm environmental hazard testing and report.	3	Yes
5) Abatement of hazardous materials.	15	Yes
6) Off-hours abatement of hazardous materials on adjacent floors.	5	Yes
7) Re-feed services / utilities as needed to existing areas disrupted by construction activities.	5	Yes
8) Installation of temporary utilities needed for construction.	3	Yes
9) Confirmation of in-wall utilities.		
10) Remove and salvage for relocation; paging speakers, card readers and cameras.	3	
11) Demolish ceiling supported M/E devices.	3	
12) Demolish ceilings.	3	
13) Coordinate shutdown and demolition of roof top air handling unit.	10	Yes
14) Coordinate shutdown and demolition of above ceiling electrical auxiliary systems.	4	
15) Coordinate shutdown and demolition of above ceiling electrical lighting systems.	4	
16) Coordinate shutdown and demolition of above ceiling electrical power systems.	4	
17) Coordinate shutdown, capping and demolition of above ceiling sprinkler system.	5	Yes
18) Coordinate shutdown, capping and demolition of above ceiling plumbing systems.	4	Yes
19) Coordinate shutdown, capping and abandon in place 2nd floor ceiling plumbing lines that serve this area.	4	Yes
20) Coordinate shutdown, capping and demolition of above ceiling steam	4	Yes

heating system.		
21) Coordinate shutdown, capping and demolition of above ceiling HVAC system.	4	Yes
22) Demolish steam heating units and window air conditioners.	5	Yes
23) Demolish doors.	2	
24) Demolish remaining Canteen equipment/shelves/etc.	2	
25) Demolish toilet room fixtures, partitions and accessories.	2	
26) Remove wall finishes on offices partitions to remain.	4	
27) Demolish partitions.	3	
28) Demolish flooring.	3	
29) Patch abandoned floor and wall penetrations.	1	
Construction:	Duration Approx. Work Days	Potential Off Hours Work
1) Patch roof penetrations and voids resulting from mechanical demolition.	3	
2) Install new air handling unit in mechanical room.	15	Yes
3) Existing mechanical room HVAC rework.	10	Yes
4) Layout partition walls and install tracks.	2	
5) Above ceiling gravity plumbing lines.	3	Yes
6) Above ceiling HVAC ductwork.	10	Yes
7) Above ceiling sprinkler piping.	7	Yes
8) Above ceiling pressure plumbing lines.	7	Yes
9) Above ceiling electrical power.	5	
10) Above ceiling lighting.	7	
11) Above ceiling electrical auxiliary systems.	5	
12) Set opening and door frames.	3	
13) Stud partition walls, install in-wall back boxes, blocking and reinforcement, frame gypsum board ceilings.	3	
14) M/E rough-in for partitions.	3	
15) Mechanical pressure tests.	1	
16) Mechanical insulation.	5	
17) Inspections.	1	
18) Board partitions.	3	
19) Drywall finish.	3	
20) Wall finishes.	2	
21) Trim wall mounted devices.	1	
22) Ceiling grid.	3	
23) Ceiling supported devices.	3	
24) Floor finishes.	10	
25) Server equipment.	25	
26) Vending equipment.	5	
27) Above ceiling inspection.	1	
28) Gypsum board ceilings.	3	
29) Ceiling tiles.	3	
30) Millwork and lockers.	7	
31) Dining room tables, chairs, etc.	4	
32) Doors, hardware and glass.	4	
33) Test and balance	3	
34) Commissioning	1	
35) Signage	1	
36) Punchlist	5	
37) Owners training.		
38) Final inspections.	1	
39) Owners office furniture and equipment.	5	
40) Remove temporary construction.	3	Yes
41) Phone and data activation.	1	
42) Occupy	1	
Phase 3B-3C	Duration Approx. Work Days	Potential Off Hours Work
Demolition:		
1) Evacuate space.	3	
2) Install temporary construction partitions and signage.	1	Yes
3) Institute infection control systems and methods.	1	Yes
4) Confirm environmental hazard testing and report.	2	Yes

5) Abatement of hazardous materials.	3	Yes
6) Off-hours abatement of hazardous materials on adjacent floors.	2	Yes
7) Re-feed services / utilities as needed to existing areas disrupted by construction activities.	3	Yes
8) Installation of temporary utilities needed for construction.	3	Yes
9) Confirmation of in-wall utilities.		
10) Remove and salvage for relocation; paging speakers, card readers and cameras.	1	
11) Demolish ceiling supported M/E devices.	1	
12) Demolish ceilings.		
13) Coordinate shutdown, capping and demolition of plumbing lines in 2nd floor ceiling.	3	Yes
14) Coordinate shutdown, capping and demolition of roof drains cap and abandon in place in 2nd floor ceiling.	3	Yes
15) Coordinate shutdown, capping and demolition of natural gas piping.	2	Yes
16) Reroute vent and exhaust piping from 2nd floor ceiling to building exterior.	3	Yes
17) Coordinate shutdown and demolition of roof top air handling unit.	10	Yes
18) Coordinate shutdown and demolition of above ceiling electrical auxiliary systems.	2	
19) Coordinate shutdown and demolition of above ceiling electrical lighting systems.	2	
20) Coordinate shutdown and demolition of above ceiling electrical power systems.	2	
21) Coordinate shutdown, capping and demolition of above ceiling sprinkler system.	3	Yes
22) Coordinate shutdown, capping and demolition of above ceiling plumbing systems.	2	Yes
23) Coordinate shutdown, capping and abandon in place 2nd floor ceiling plumbing lines that serve this area.	3	Yes
24) Coordinate shutdown, capping and demolition of above ceiling steam heating system.	2	Yes
25) Coordinate shutdown, capping and demolition of above ceiling HVAC system.	3	Yes
26) Demolish steam heating units and window air conditioners.	2	Yes
27) Demolish doors.		
28) Demolish remaining Server equipment/shelves/etc.	1	
29) Demolish partitions.	1	
30) Demolish flooring.	2	
31) Demolish exterior shell elements as required for new Solarium.	4	Yes
32) Demolish existing roof are for new Solarium.	5	Yes
33) Patch abandoned floor, roof and wall penetrations.	2	

Construction:

	Duration Approx. Work Days	Potential Off Hours Work
1) Patch roof penetrations and voids resulting from mechanical demolition.	3	
2) Install new air handling unit in mechanical room.	15	Yes
3) Structural work for Solarium.	5	Yes
4) Install Solarium.	10	Yes
5) New roofing and flashings.	7	Yes
6) Layout partition walls and install tracks.	1	
7) Above ceiling gravity plumbing lines.	2	Yes
8) Above ceiling HVAC ductwork.	3	Yes
9) Above ceiling sprinkler piping.	3	Yes
10) Above ceiling pressure plumbing lines.	2	Yes
11) Above ceiling electrical power.	3	
12) Above ceiling lighting.	3	
13) Above ceiling electrical auxiliary systems.	2	
14) Set door frames.	1	
15) Stud partition walls, install in-wall back boxes, blocking and reinforcement, frame gypsum board ceilings.	1	
16) M/E rough-in for partitions.	1	
17) Mechanical pressure tests.	1	
18) Mechanical insulation.	3	
19) Inspections.	1	
20) Board partitions.	1	
21) Drywall finish.	2	
22) Wall finishes.	1	

- 23) Trim wall mounted devices.
- 24) Ceiling grid.
- 25) Ceiling supported devices.
- 26) Floor finishes.
- 27) Above ceiling inspection.
- 28) Gypsum board ceilings.
- 29) Ceiling tiles.
- 30) Millwork
- 31) Dining room tables, chairs, etc.
- 32) Doors, hardware and glass.
- 33) Test and balance
- 34) Commissioning
- 35) Signage
- 36) Punchlist
- 37) Owners training.
- 38) Final inspections.
- 39) Remove temporary construction.
- 40) Phone and data activation.
- 41) Occupy

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